THE STUDY OF HUMAN COMMUNICATION FROM THREE SYSTEMS PARADIGMS

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ABSTRACT

THE STUDY OF HUMAN COMMUNICATION FROM
THREE SYSTEMS PARADIGMS

By

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Human communication may be studied from a variety of intellectual perspectives. The purpose of this essay is to explore the usefulness of one particular approach: the systems paradigm.

The introductory chapter examines three general scientific models for studying the communication process: the mechanistic, organic, and systemic. The defining characteristics of each model is specified, examples are presented, and the efficacy of each for communication is assessed. It is argued that the systems paradigm permits the study of several important dimensions of the communication process which are not an integral part of the other models. The three system paradigms, cybernetics, structural-functionalism, and general systems theory, are distinguished to establish the framework for the remainder of the essay.

In three separate chapters, each of the three paradigms is examined with respect to a common set of central issues. First, a brief historical overview is presented that traces the intellectual heritage of the paradigm. Second, the logical and empirical requirements of the paradigm are outlined and examined in considerable detail. Third, the communication process is conceptualized from that particular system perspective. That is, the

communication process is defined such that it meets the logical and empirical requirements of that paradigm. Several examples are provided. Finally, each chapter examines the implications for empirical research of conceptualizing communication from that perspective; these include data gathering, analysis, and suggestions for future research. Several other important topics, e.g., openness, causality, purpose, etc., are also discussed.

The concluding chapter considers several of the implications of viewing communication as a complex, adaptative system. First, the problem of complexity is examined and two strategems are presented for dealing with it: subsystem analysis, for those systems which are internally observable, and black box analysis, for those systems which are not internally observable. Next, the issue of adaptation of communication systems is discussed. Maruyama's (1968) model of morphogenesis and Zetterberg's (1966) axiomatic deductive theory are compared as a basis for formulating a typology of change in communication systems, for which logical and empirical conditions are specified. The final section of the chapter explores the issue of explanation. The systems paradigm of explanation is defined as the process of establishing isomorphism between a logical calculus and empirical reality. This definition is contrasted with four alternative explanatory genres, including the covering law model, as a basis for arguing that system explanations are more appropriate to the logic of communication.

Throughout the essay, the attempt is made to demonstrate that the system paradigm provides a viable, powerful alternative to non-system frameworks for conceptualizing communication. But beyond showing that it is possible to view communication this way, it is argued that it is necessary to do so because it is required by the nature and logic of the communication process. Further, it is argued that such a conceptualization will provide new solutions to old problems, make contemporary one more manageable, and generate new but highly productive issues for future exploration and research.

Accepted by the faculty of the Department of Communication, College of Communication Arts, Michigan State University, in partial fulfillment of the requirements for the Doctor of Philosophy degree.

Director of Thesis

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The writing of a doctoral dissertation, like so many other complex, adaptive communication processes in today's world, may be usefully viewed from a systems perspective. Inputs from a wide variety of sources all converge into the output which appears on the following pages. A system developed with definite structures which served a variety of functions and changed over time. It was a goal-oriented, adaptive system, controlled in large part by the continual feedback provided by an intellectual milieu. In short, the preparation of this dissertation was a microcosm of its subject matter.

These, then, are the people who in large part comprised this system. To each, for what they contributed, I express my deep appreciation:

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Jannie Marie and Todd Michael, who shared so many of my problems and joys in writing this essay.

Finally, this thesis is, but a record at a point in time of an ever-changing intellectual system, one which exists primarily in the minds of those who share it. It evolves and grows as each person applies his

own unique ideas and talents to it. To those who read this essay, I express my hope that you will adopt a critical orientation which will help to develop and improve the ideas it contains. Accept in advance my appreciation for sharing with me your reactions and ideas at your nearest opportunity.

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CHAPTER I

INTRODUCTORY

Human communication has been studied from a variety of intellectual perspectives. Philosophy, psychology, sociology, anthropology, speech, and journalism have each, from the perspective of their respective subject matters and methodologies, contributed to the development of the scientific discipline of communication which has emerged over the past quarter century. Such diversity and eclecticism in approach raises the question as to which intellectual framework is most useful for conceptualizing the communication process. The answer which has occurred with increasing frequency, both within communication and its contributory disciplines, is the systems paradigm.

The concept of system consists of a set of assumptions, definitions and analytic procedures which creates a conceptual framework for structuring and/or discovering reality. In its most general form the term "system" refers to an abstract set of concepts and relations that can be applied to the analysis of virtually any given phenomenon.

If system analysis is to benefit communication research, it must be of greater applicability to communication concepts and variables than traditional frameworks and offer better explanations than those provided by other approaches. This superiority, defined as scientific usefulness, may take several forms: identifying new relations not previously hypothesized, clarifying ambiguous relations, developing new concepts, offering more parsimonious explanations, explaining communication processes that are intractable to other approaches, and/or producing more usable formulations of previously explained communication events. The crucial implication of this statement leads to the question: does the application of the concept of system to communication phenomena provide these advantages? This essay offers an affirmative reply.

There are several reasons that commend an intensive examination of the concept of system. First, a number of scholars have argued that the concept of system is extremely useful to our understanding of the communication process. Berlo (1970), in his recent Essays on Communication, states:

> I am not arguing that communication cannot be viewed outside the concept of system...and certainly not that it has not been so viewed. I am suggesting, however, that it is not fruitful to talk about communication other than as it occurs within a system frame...and that our understanding of communication principles and our creation of new principles will not occur unless we do impose the system concept on our inquiry (p. III-8).

Second, few terms are more ubiquitous in the current communication literature than that of system. The high frequency of its occurrence suggests that the concept is seen as crucial by communication scientists, and that in itself recommends that it be given a careful review.

Third, much of the logical use of the concept of system is inadequate. For example, writers often use the term system assuming that there is one single, standard definition of the term. Such is not the case, however. Examination of the literature reveals that the term is not univariate in meaning; rather, there are at least three alternative interpretive frameworks which can be referred to by the concept of system: general systems theory, cybernetics, and structural-functionalism. Given that there are alternative logical frameworks that are frequently referenced by the same term, it is vital that they be examined to sort out the logical differences and to see how our conceptualization of communication changes as a function of which framework is employed. Further, it is also important to be able to see the similarities and differences among the system and non-system alternatives and to be able to translate back and forth from one conceptual frame to the other.

Finally, much of the empirical usage of the concept of system is inadequate. For example, while the term is popular in theorizing or discussing communication, it is rarely employed in research. One result of this fact is that communication scholars typically fail to distinguish the empirical from the logical requirements for applying the concepts to communication. Another is that little attention is paid to the methodological implications of utilizing the systems paradigm; hence, when it is used, it is often used incorrectly. Given these empirical inadequacies, it is necessary to clarify the research requirements and implications before any advantages promised by the systems paradigm can be realized.

Overview

For these reasons, this essay will undertake an examination of the applicability of the concept of system to the communication process. The first chapter is devoted to a comparison of three alternative models for conceptualizing communication: the mechanical, organic, and systems models. The defining characteristics are specified, several examples are provided, and the advantages and disadvantages of each are discussed.

Chapters two, three, and four extend the analysis begun in the first chapter; all three have the same basic organization, but each is devoted to a different system approach. In each I shall review the model's historical roots, examine how it is conceptualized and applied to non-communication phenomena, and then attempt to conceptualize the communication process from within that perspective. The chapters will conclude by tracing the implications for communication research.

In the final chapter I shall turn to several additional problems. Communication will be defined as a complex, adaptive system. This requires that I explore the problem of complexity, offering suggestions for dealing with it, and that I examine the problem of adaptation. Current equilibrium models of communication will be critiqued and I will offer a systems model of adaptation. Next, I will take up the question of the system paradigm as a valid form of explanation, suggesting that it is more appropriate for communication phenomena than more traditional frameworks. Finally, I will review and compare the three systems paradigms which constitute the substance of this essay.

Throughout this essay I will seek to demonstrate that the system perspective provides a viable and useful alternative to non-systems frameworks for conceptualizing communication. Hopefully, the advances offered by the systems paradigm, and the reconceptualization of the communication process that it implies, will provide new solutions to old problems, and make contemporary ones more manageable.

Communication and Models

At the outset, it is important to take a stand on the conditions necessary for an adequate model of communication in order that it might be used as a touchstone for future reference. I do not mean to imply that the following is the only set of conditions which define communication, nor that it is the optimal or minimal set. Rather, it is simply a matter of revealing my intellectual biases so that the criticisms that I level at other conceptualizations may be assessed in light of an acknowledge position.

I would stipulate that communication should be viewed as (1) a set of symbols and their rules of combination, which are (2) flexible and (3) transmitted among symbol users, (4) to achieve some purpose. This conceptualization of communication can be modeled from a number of perspectives, but it will be argued throughout this essay that the systems paradigm best captures the logic implied by this definition.

Symbols are, of course, the *sine qua non* of virtually all definitions of communication. Symbols are, in an abstract sense, a form of structure, and it is structure which is transmitted through time and space. But the transmission of symbol structure--at least in human communication--is governed by rules, not laws.

Symbols are flexible. That means that one symbol can possess several referents and likewise that several symbols can pertain to the same referent. To emphasize the flexibility of symbols is to emphasize the dependence of meaning on the context in which the symbols occur.

That communication requires transmission among symbol users has been the focus of many previous definitions. Unfortunately, both of these aspects typically are studied by people outside the discipline of human communication: transmission tends to be the province of electrical engineers, and users, if human, the subject of psychologists. Nevertheless, they are essential aspects of the process and must be included in our definition.

Communication should be viewed as purposive. It can, of course, be defined from a non-purposive, deterministic viewpoint, but such an approach has so far proved intractable to scientific analysis and also has devastating implications for our view of the human condition. I hold, consequently, that it is useful to conceive of man as communicating purposively, the two primary forms of which are coordination and expression.

It is probably true that no model of communication short of a direct simulation will ever be able to adequately reflect all four conditions. But some models reflect these requirements better than others, and I shall hold as a key evaluative criterion that the closer the logic of any given model reflects these characteristics, the better that model is.

Until recently, two major conceptual models, the mechanistic and the organic, have dominated man's scientific inquiry regarding man. Originating in the seventeenth and nineteenth centuries respectively, both are derived from non-social areas of inquiry, specifically the physical and natural sciences (Buckley, 1967). At first it may seem strange that social philosophers and communication scientists should employ models from other disciplines rather than develop their own. The problem lies not in the fact that they have not tried to develop their own, but rather that in comparison with physical science models, social scientists have not been successful in generating adequate explanatory models of social behavior.

From an historical perspective, the use of the mechanical and organic models is understandable. Until the seventeenth century man's ability to explain and control any of his environment--physical or social--was woefully inadequate. But the breakthrough by the natural sciences in developing viable conceptualizations and explanations inspired social scientists to adopt models based upon the natural science conceptualization of the world, all of which was done in hopes of achieving similar success in explaining human behavior; thus, physical and biological science success bred social science imitation. Unfortunately, the hoped-for success has never been realized; social and communication science are still without a viable model of human behavior. One of the major reasons for this failure is that many physical and biological models have been adopted without adequate attention to the isomorphism between the logical and empirical requirements of the original model and the human and social phenomenon to which it is being applied.

Since these two conceptual frameworks have had so significant an impact on the study of human behavior, I will in the next few pages review these schemata, exploring their advantages and disadvantages in preparation for a discussion of a third conceptual alternative, which, I shall argue, is more suited to the explanation of communication phenomena, the systems perspective.

The Mechanical Model

Near the end of the middle ages, craftsmen and artisans developed increasing skill in the design and control of machines such as clocks and mechanical pumps. In the seventeenth century Newton applied the idea of mechanisms to the physical world, particularly gravitational astronomy and did so, as is well known, with great success.

From Newton's mechanical explanation of the physical world it is possible to extract a number of specific ideas about the manner in which mechanistic models operate. Among them are the notions of

> . . . a whole which was completely equal to the sum of its parts; which could be run in reverse; and which would behave in exactly identical fashion no matter how often those parts were disassembled and put together again, and irrespective of the sequence in which the disassembling or reassembling would take place. It implied consequently the notion that the parts were never significantly modified by each other, nor by their own past, and that each part once placed into its appropriate position, with its appropriate momentum, would stay exactly there and continue to fulfill its completely and uniquely determined function (Deutsch, 1968, p. 388).

As indicated earlier, seventeenth century physical scientists were so successful (in comparison with scientists of previous centuries) in explaining the physical universe in terms of mechanical principles that the philosophers of that day who were intrigued with explaining human behavior hoped to achieve similar success by adopting the mechanical schema. As Mischel (1969) indicates:

> Ever since the revolution in the physical sciences, some theorists have hoped to build psychology on foundations similar to those that physics received in the seventeenth century . . . . Hobbes deliberately set out to apply the 'new method' of Galileo and Harvey to psychology. Starting from the premise that human beings are, after all, material systems--for says Hobbes, 'what is the heart, but a spring; and the nerves, but so many strings; and the joints so many wheels, giving motion to the whole body' (1651, p. ix)--Hobbes attempted to extend the concepts used for explaining the motions of bodies to the explanation of human behavior (p. 5).

In the field of sociology the adoption of the mechanical model was even more extensive than in the psychological disciplines, as can be seen in the following quotation from Buckley (1967).

> Thus we find conceptions of moral or social space in which social events occur; position in social space, and a system of social coordinates defining man's position in it; social processes as results of the 'gravitation' or attraction and inertia of individuals and groups, the latter regarded as a system in an equilibrium of centrifugal and centripetal forces. Social organization, power and authority were resultants of the 'pressures' of 'social atoms' and 'molecules': hence arose 'social statics' or a theory of social equilibrium analogous to statics in physical mechanics, and 'social dynamics' involving motion or change as a function of time and space expressible by various mathematical curves (p. 8).

Thus, the mechanistic model conceives of man's behavior as analogous to a physical system of opposing forces maintaining equilibrium. Among the many social theories in use today which share this world view are the works of Sorokin, Parsons, and Homans (Buckley, 1967, p. 9). Also in this category, and perhaps better known to communication scholars, are Festinger's (1957) theory of cognitive dissonance and Newcomb's (1953) coorientation model.

Since the major purpose of this essay is to examine the applicability of the systems framework to communication, it should be a useful contrast at this juncture to examine how communication operates if conceptualized from the mechanistic point of view. One way to proceed is to review existing communication models to find those which fall into this category. Unfortunately, however, as the next several paragraphs should demonstrate, such a review yields only a discouraging commentary on the status of contemporary communication theory.

There are numerous models of the communication process currently in vogue. One of the earliest was the Lasswell (1948) "Who, says what, in which channel, to whom, with what effect" model. The Berlo (1960) SMCR model, which was built on the Shannon and Weaver (1949) model, identified the Source, Message, Channel, and Receiver. McCroskey (1968) explicitly added the feedback loop to Berlo's model, and Dance (1967) attempted to show the non-circularity of the SMCR + feedback model by transforming it into a helix.

We could review many others, such as the Westley-MacLean (1957) conceptual model, the Becker (1968) mosaic model, and the Barnlund (1970) transactional model, etc., but such a review is fruitless, for despite their proliferation, virtually all contemporary theories of communication lack the sophistication necessary to be classified as mechanical or organic much less as systems models. Rather, they tend to be pictorial or verbal descriptions of a poorly conceptualized, vaguely defined phenomenon. Each one provides an alternative conceptualization of communication, but not one of them (1) offers systematic propositions for relating their constructs, (2) employs a logical calculus that warrants expectations (i.e., permits logical deductions), (3) utilizes conceptualizations which are amenable to mathematization, nor (4) is testable, and hence either verifiable or refutable. And while some of them give verbal assent to sophisticated philosophical notions such as continuous process, interaction, etc., none has conceptualized communication in a manner which admits to the formal analysis and verification of these phenomena. For example, Arundale (1971) states that while the concept of process is important to many of the theories, no current model of communication attempts to account for changes over time (except to assert that changes will occur); hence, they are all pre-dynamic.

A notable exception to this state of affairs, and one which will provide us with an example of a mechanistic communication theory, is the "theory of linear force aggregation" recently developed by Woelfel (1970). The theory attempts to account for human behavior by conceiving of it in terms that are formally identical to the Newtonian laws of motion. Behavior is defined as a rate (frequency per unit of time) which is directly dependent upon the self-conception. The self-conception is formed and determined by two sources, direct observation and symbolic communication, both of which are conceptualized as rates of information transmission. The theory then hypothesizes quite explicitly that "... the rate of engaging in a given behavior equals the aggregate of all rates of that behavior presented to ego as information by all sources (Woelfel, 1970, p. 54)." A cognitive space where the self-concept occurs and a space where the resultant behavior occurs are defined; they are both Euclidean.

The theory accounts for the impact of messages on the change of self-concept (and hence, on the change of behavior) according to Newton's Second Law, $F = ma$. That is, the impact of a message on self-conception and behavior (its force) is a direct function of the difference between the proposed and the current attitude (acceleration expressed as rates of behavior) and the number of messages that the person has previously received about the topic (the inertial mass to be overcome). Formal identities with the First and Third Laws are also drawn. For the First

Law, if no message impacts on the system, the system remains unchanged in its present state. For the Third Law, "...action upon the attitude is equal and opposite to the action on the change message (Woelfel, 1970, p. 60)."

Thus, the mechanistic analogy is complete. Except for using attitudes and informative messages in place of inertial masses and forces, the concepts used throughout are the same as the continuous ratio measures used in physics: distance, time, force, and angle. Further, these variables are assumed to be related in Woelfel's account of human behavior in the same way that they are in Newtonian physics; e.g., the "acceleration" of an attitude is related to its "mass" and an applied message "force" in the same way that the acceleration of a projectile is related to its mass and an applied force.

There are a number of advantages to Woelfel's theory. First, it provides a new way to conceptualize at least a part of communication, i.e., a proposed rate of behavior. Second, it employs a logical calculus (Newton's Laws and ratio level mathematics) which permits logical deductions; hence the propositions and implications of the theory can be clearly and unambiguously articulated. Finally, it is eminently testable and hence verifiable or refutable.

On the other hand, we might raise some questions about the theory. First, Woelfel's theory tells us little about messages--what it is about messages that causes them to impact on behavior in the way asserted. Second, (and this is a criticism of mechanics in general) the mechanical laws have proven inadequate to explain biological phenomena. For example, it was necessary to modify (generalize, not contradict) the physical theory of thermodynamics so that it would be applicable to irreversible living systems before advances could be made in the explanation of biological phenomena. By a similar argument, it is reasonable to ask (and later attempt to answer, cf., Chapter V) whether the logic of communication behavior has certain properties which can never be captured by the logic of mechanics. Specifically, if communication is viewed as an externally and/or internally open process, then the logic of closed systems seems inappropriate. Finally, an objection may be raised regarding Woelfel's parallel with the Third Law. While it is plausible that a message will produce a change in attitudes, it is difficult to see how the impact of a message on an attitude can affect the change message.

It is worth noting the advantages and disadvantages of the general mechanistic model. On the positive side, it is clear that the mechanistic model was historically superior to previous mythological or theological explanations of human behavior. From a contemporary viewpoint the mechanistic model is still superior to strictly verbal or pictorial models which fail to define their relations. Further, the mechanistic model makes a number of simplifying assumptions (such as linearity of relationships), which tend to make it easier to grasp and operate with than more complex models. Finally, the mechanical model is testable; it is possible to know where and how the model is inadequate as an explanation of empirical reality.

There are also several major problems with the model. First, a closed equilibrium system is assumed which does not account for growth, which means that the model fails to account for one of the major phenomena of living and symbolic systems. Second, as Toulmin (1969, p.

100) argues, the use of mechanics imposes a logic on the phenomenon that is being studied, and it may well be the case that the logic of communication systems (symbol systems) is fundamentally different from the logic of material systems. The third and fourth criticisms come from Bertalanffy (1968) who calls the mechanical view of man "the robot model of human behavior". He argues (a) that it treats man as a passive rather than an active component in the system and (b) that it is a conceptualization of man which is required in order to support the world view of mechanized and commercialized western society. In somewhat strong terms he asserts that

> The image of man (as robot) is metaphysics or myth, and its persuasiveness rests only in the fact that it so closely corresponds to the mythology of mass society, the glorification of the machine, and the profit motive as some motor of progress (p. 191).

Needless to say, Bertalanffy opts for an alternative conceptualization of man's behavior.

As a basis for future comparison with the other models let me summarize the defining characteristics of the mechanical model:

1. The whole is equal to the sum of its parts. This implies that analysis is atomistic rather than holistic, and that the system operates on the basis of summativity rather than interaction.

2. The system is closed to outside influences. This means that any variable not included in the system is assumed to assert no influence on the behavior of the system.

3. The history of the system is unimportant. This is so because the system is seen as reversible; it can be run forward or backward.

4. The system seeks equilibrium, the balancing of opposing forces.

5. Entropy, the amount of disorganization, never decreases: over time the system will either retain the same amount of order or become more disordered.

The Organic Model

The organic model was developed in the biological sciences because the mechanical model proved inadequate as an explanation of biological events. For example, the mechanical model cannot account for either the growth of an organism or the evolution of a species. As Deutsch (1968) points out, the organic model is different from the mechanical model in several important ways:

> According to this classical view, an "organism" is unanalyzable, at least in part. It cannot be taken apart and put together again without damage. As Wordsworth put it, "We murder to dissect". The parts of a classical organism, in so far as they can be identified at all, not only retain the functions which they have been assigned but in fact cannot be put to any other functions (except within narrow limits of "de-differentiation" which were often ignored), without destroying the organism. The classical organism's behavior is irreversible. It has a significant past and a history--two things which the classical mechanism lacks--but it is only half historical because it was believed to follow its own peculiar "organic law" which governs its birth, maturity, and death and cannot be analyzed in terms of clearly identifiable "mechanical" causes (p. 389).

Scientists who have applied the biological model to human social and communicative acts have done so on two different levels: (1) the "organismic" or individual level, and (2) the "organic" or species level.* The organismic approach yields an anatomical/physiological model of communication which (1) identifies structure, (2) locates regulatory mechanisms, (3) emphasizes cooperation of components, and (4) emphasizes growth only to maturity (Buckley, 1967, pp. 11-17).

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*The confusion provided by reference to the "organic model" and the "organic version of the organic model" is unfortunate; usage in sociology is equally confused. Our discussion and the context should enable the reader to maintain the appropriate distinction.

The first scientific application of the organic model to society was made by Herbert Spencer. Utilizing the organismic version of the organic model, Spencer argued that society functions like a body, and he sought to define social counterparts to the heart, brain, circulatory system and other aspects of the behavior of homeostatic biological systems. Homeostasis, originally defined by Cannon (1939), is a concept designed to indicate the "dynamic, processual, potential-maintaining properties of basically unstable physiological systems (Buckley, 1967, p. 14)." Homeostasis is an important property of individual biological systems, but it is important to note (as will be discussed more fully later) that the concept of homeostasis is a structure-maintaining rather than a structure-elaborating process, or to use Maruyama's (1968) terms, a morphostatic rather than a morphogenetic process.

By contrast, the organic (species) approach yields an ecological model which emphasizes (1) continuity of rather than the structure of the species, (2) competition rather than cooperation among parts, and (3) continual change in the nature of the species in addition to the mere maintenance of characteristic features (Buckley, 1967, p. 11-17). In sociology this view of man eventually led to the doctrine of Social Darwinism and it is reflected in the communication discipline by studies on conflict resolution and message competition.

The distinction between the organismic and the organic versions of the organic model is an important one to note for communication scientists often attempt to explain both intrapersonal and interpersonal communication events. Clearly, when the biological model is employed, a distinction must be made between the individual and the species versions.

There are three primary advantages to modeling communication after organic processes. The first is that the organic model explains a type of phenomenon which is beyond the explanatory powers of mechanics, e.g., growth and evolution. If more powerful results are achieved by conceiving of communication as an animate rather than an inanimate process, then the organic model is clearly more appropriate than the mechanical model. Second, the organic model accounts for several important characteristics such as the maintenance of a given structure in a changing environment. Finally, like the mechanical model, the organic model is testable, provided of course, that it is used as more than a simple verbal analogy.

There are also several drawbacks to the organic model. First, the organismic version of the organic model does not readily account for some important communication characteristics, such as structural-elaboration rather than structural-maintenance. Second, it is a more complex model than the mechanical model. Complexity in a model is an asset only if the phenomenon being modeled is complex and if the model incorporates a methodology which can adequately analyze the complexity. In most previous applications of the organic model to social phenomena such an appropriate methodology has not been employed. Third, it is quite possible that the logic of organic entities is not the same as the logic of communication systems. Finally, the failure to distinguish between the organismic and the organic versions of the organic model has often produced highly contradictory and confusing results.

As I did for the mechanical model, let me now summarize the defining characteristics of the organic model:

1. The whole may be more than the sum of its parts. This means that analysis should be holistic rather than atomistic, and that the system operates on the basis of interaction rather than summativity.

2. The system is open to the import and export of materials.

3. The history and the past of the system are important for the interpretation of the system's present and future behavior. The system is, at least in part, irreversible.

4. The system maintains unstable dynamic equilibrium at some distance from true equilibrium.

5. Entropy may decrease.

The Systems Model

Having reviewed the mechanical and organic models, let us now turn to the systems paradigm. Since the remaining chapters of this essay are devoted to a fuller explication of this model of inquiry, I will here provide only a brief overview.

It will be useful to start our analysis by showing what the systems approach is not. In one sense, I have already done this by suggesting that the systems approach is neither mechanistic nor organic. There is, however, an alternative way to make the distinction which may provide additional clarity.

Krippendorff (1971) discusses three non-systems research strategies which shall be used to distinguish the systems from the non-systems approaches. The first strategy attempts ". . . to isolate a single and often unique event and to describe it from various perspectives (p. 15)." This approach is well illustrated by the 1960 Kennedy-Nixon TV debates. The debates could be viewed, collectively, as a unique communication event. To be explained scientifically, however, an event must be placed in a class of events for which generalizations can be obtained. If the debates are viewed as belonging to the class of TV political programs or public debates, there might be some possibility of scientific explanation. But if they are viewed as a unique event, they defy such explanation (Klapper, 1960, pp. 5-9). This statement is generally true of any historical event viewed as a unique phenomenon, which is not to say that this type of event is not worthy of study. It merely means that the systems approach cannot analyse isolated and unique events.

A second non-systems approach attempts ". . . to single out for attention one or more observed variables and to try to understand their variation in terms of their dependencies on another set of observed variables (p. 15)." This strategy has traditionally been the *sine qua non* of communication research. But while it has proven to be extremely useful, its chief weakness from a systems perspective lies in the fact that it fails to account for mutual causal dependencies and complex interactions. The reason for this is that the direction of causality is assumed or manipulated, and many of the complex interactions are controlled out of existence.

The final distinction derives from attempts ". . . to reduce an obviously complex organization by analysis into certain individually comprehensible units without regard to the relationships among them (p. 16)." The argument here is that if a complex phenomenon has holistic properties, the behavior of that phenomenon cannot be discovered by analyzing the components separately; a thorough understanding also requires knowledge about the relations among the components.

Definitions of the concept of system abound, and though there is considerable similarity among these definitions, there is some divergence. One of the issues around which these differences cluster is whether the system being defined is a formal, abstract, conceptual system, or an empirical, concrete, real system.

Rapoport (1970) presents a good example of the first type of definition. A system is:

> (1) A set of states (each of which must be individually identifiable and unambiguously distinguishable relative to each other),
>
> (2) One or more transformations defined on at least some of the set of states, and
>
> (3) The transformation is defined on states at different points in time so that states at a given point in time imply states at some future point in time (p. 17).

Another fairly abstract definition is the one offered by Hall and Fagen (1968): "A system is a set of objects together with relationships between the objects and between their attributes (p. 81)." And finally, the definition offered by Meehan (1968): "A system consists of a set of variables (V_1, V_2, $V_3 \ldots V_n$) and a set of rules that define the interactions among those variables (R_1, R_2, $R_3 \ldots R_n$) (p. 50)." These three should suffice to illustrate the defining characteristic of this type of system definition, which Krippendorff (1971) identifies as the ". . . unambiguous identification of the properties according to which something does or does not belong to the class of things defined (p. 3)."

An example of the second type of system definition--the empirical, concrete, real system--is provided by Rapoport (1970):

(1) Many constituent elements which have some properties in common,

(2) A structure, i.e., recognizable relationships among the elements which are not reducible to a mere accidental aggregation of elements,

(3) A behavior or a function, i.e., they show efforts to maintain a short-term steady state at which some essential structure, the "identity" of the system, remains invariant (a) in spite of changes in elements, cells or membership that go on within them and (b) in spite of changes in the environment with which they interact, and

(4) A history, i.e., they undergo slow, long-term changes in those structures, i.e., they grow, develop, evolve or degenerate, disintegrate, die (p. 22).

A final example is the definition given by Berrien (1968):

> A system is defined as a set of <u>components</u> interacting with each other and a boundary which possesses the property of filtering both the kind and rate of flow of <u>inputs</u> and <u>outputs</u> to and from the system (pp. 14-15).

Apart from formal definitions, a review of contemporary systems research appears to reveal three alternative ways to conceptualize systems: (1) cybernetics, (2) structural-functionalism, and (3) general systems theory. It is these three alternatives that I shall explore in depth in order to determine the applicability of the system approach to communication phenomena. Briefly, cybernetics is the study of systems which communicate and exercise control over their own behavior. Stated another way, cybernetics is the study of self-directed systems based upon the central concepts of goal, feedback, and comparator. As should become apparent later, cybernetics may also be used to explain the phenomenon of growth.

Structural-functionalism may be defined as ". . . the practice of interpreting data by establishing their consequences for larger structures in which they are implicated (Merton, 1957, pp. 100-101)." This definition implies that researchers seek to identify the structures in a system which enable it to operate and maintain itself. Structural-functionalism has been an important research orientation in biology and sociology, but has only recently been introduced to the communication discipline.

General systems theory is an attempt to create an encompassing theory of systems and their properties wherever they may be found. It ". . . seeks to classify systems by the way their components are organized (interrelated) and to derive the 'laws,' or typical patterns of behavior, for the different classes of systems singled out by the taxonomy (Rapoport, 1968, p. xvii)." Such general laws may be extremely helpful in understanding communication if it can be conceptualized within the general systems framework.

Individually, each of these three approaches to the study of systems has different implications for the way to conceptualize communication, and it will be my task in this essay to examine these carefully. But collectively, they constitute a revolutionary scientific world view, one which, if adopted, has far-reaching implications for communication research. It is a view which Laszlo (1972) asserts is ". . . of encompassing range and highly integrated self-consistency (p. 27)."

The major problems which are the focus of the systems approach are summarized by Buckley (1967).

> . . . wholes and how to deal with them as such; the general analysis of organization--the complex and dynamic relations of parts, especially when the parts are themselves complex and changing and the relationships are nonrigid, symbolically mediated, often

> circular, and with many degrees of freedom; problems of intimate interchange with an environment, of goal-seeking, of continual elaboration and creation of structure, or more or less adaptive evolution; the mechanics of "control," of self-regulation or self-direction (p. 2).

And when specifically applied to communication, Krippendorff (1972) argues that

> Systems approaches provide a methodology for dealing not with one communication link at a time but with a large number of them simultaneously; not with binary relations among a single sender and a single receiver of information but with many-valued and dynamic dependencies among a possibly large number of communicators; not with one-way processes of communication but with interaction and with circular flows (in press).

And again from Krippendorff (1972):

> Of particular interest are the systemic properties of existing or anticipated information structures or communication networks, for example, their patterns of adaptation, their capacity to transmit and store information; their ability to self-organize, their rate of growth, the extent to which they are goal-seeking or the equilibrium conditions they exhibit (in press).

These are problems and properties of communication which previous conceptualizations have overlooked. It is a selection of these problems that shall be addressed in this essay.

As before, I should stipulate the defining characteristics of the systems model:

1. The whole may be more than the sum of its parts, but the emphasis is on the organization of the parts rather than the substance from which they are made. Interaction is the basis of system operations and analyses are holistic rather than atomistic.

2. The system is open to the import of energy <u>and</u> information. It may also be open internally, i.e., capable of generating new states of the system from within.

3. The history and the past are significant for interpretation of the present and future behavior of the system. It is, at least in part, irreversible.

4. The system maintains dynamic equilibrium but the emphasis is upon structural change rather than structural maintenance.

5. Entropy may decrease.

A comparison of the organic and systems models will reveal that the organic model is incorporated in the systems model, but the reverse is not true. Further, the systems and organic models are significantly different from the mechanical model, and cannot really be reconciled with it.

Summary

In this chapter, the stage has been set for the analysis which will be undertaken in the remainder of this essay. To do so, I have examined three models for conceptualizing communication: the mechanical, organic, and the systems models. The defining characteristics were specified, and it was argued that the systems paradigm permits the study of several important dimensions of the communication process which are not an integral part of the other models. Examples were provided and the advantages and disadvantages of each model were discussed. With this background, it is now possible to submit each of the three systems approaches to critical examination.

CHAPTER II

COMMUNICATION AND CYBERNETICS

Cybernetics was defined by its founder, Norbert Wiener (1948), as the science of control and communication in the animal and the machine (p. 19). More precisely, the primary goal of cybernetics is control and communication is the means whereby control can be exercised. Thus, as an abstract science, cybernetics contains the general theory and principles of self-regulating control systems; its practical applications, however, are ubiquitous--in biology, physics, sociology, engineering, economics, etc.

In this chapter, I shall examine the applicability of the cybernetic systems model to human communication. Prefatory to examining the necessary and sufficient conditions for a cybernetic model will be a brief historical review of cybernetics. Once the model is articulated, I will attempt to conceptualize the communication process from within the cybernetic framework. The chapter will conclude with a discussion of the implications for research that are generated by such a conceptualization.

An Historical Overview

Cybernetics is a very young science. The major intellectual influences began to coalesce during World War II and finally emerged as a recognized discipline in the late 1940's. Though the history of cybernetics in academia is quite recent, the etymology of the word is ancient. Plato's writings contain the first known references to the word "cybernetics"; he used it to mean "the steersman's art", which comes from the Greek cymbe (boat) and eresso (I row). The word was often used as a political metaphor to refer to the control of "the ship of state." Herodotus used the word in his Histories (II, 194) and Homer did likewise in his epic poems (Bardis, 1965, p. 226-228). It is also interesting to note that "The Cybernesia was an Athenian festival in memory of a steersman selected by Thesus, the great Attic hero, to pilot his ship when King Minos picked a group of young men and maidens for the Minotaur (Bardis, 1965, p. 228)."

Except for a few references by Vergil the word appears to have dropped out of usage until the early nineteenth century when it was reintroduced ". . . by Andre Ampere in the form cybernetique . . . to mean the 'science of government or control (Cherry, 1957, p. 57).'" Contemporary scientific usage stems from the book entitled Cybernetics, published in 1948 by Norbert Wiener. Since that time the word has increasingly become a common household term, popularized in numerous books and magazines available to the general public.

While the principles and theory of control have been formalized only within the past quarter century, man-made control systems have been in existence for hundreds of years. The device on windmills to keep them always facing the wind affords a good example.

> It consisted simply to a miniature windmill which could rotate the whole mill to face in any direction. The small mill's sails were at right angles to the main ones, and whenever the latter faced in the wrong direction, the wind caught the small sails and rotated the mill to the correct position (Tustin, 1966, p. 324).

Perhaps the best known early feedback control system is the steam engine governor developed by Watt.

> An engine turns at an increasing speed; with it turn weighted arms, also at an increasing speed; the arms are mounted on pivots so that they are free to rise by centrifugal force as they revolve; the arms operate a value which admits power to the engine, so that the value is closed in proportion as the arms rise and the speed grows. Hence, we have a homeostat: the more the machine tends to exceed a given speed, the less it is supplied with the energy to do so; while should it fail to reach this given speed its energy supplies will be increased until it does (Beer, 1959, p. 29).

More recent history provides too many examples to enumerate; control systems are everywhere in modern life, from the simple household thermostat to the complex control and guidance systems utilized in manned space exploration.

The major intellectual influences which coalesced into the cybernetic discipline were extremely varied. As already noted, Watt (and later Maxwell) was concerned with the control and regulation of machines. The physiologist Cannon (1939) studied homeostatic mechanisms in the body. McCulloch and Pitts (1968) were logicians and neurologists interested in neutral networks and decision making, and Shannon and Weaver (1949) were electrical engineers who studied the control of telecommunication systems. The catalyst, however, was Wiener, whose 1948 book, mentioned earlier, christened the discipline.

The lineage just outlined is in no way complete, but it should serve to demonstrate the interdisciplinary nature of the field of cybernetics. As Pask (1961) states, it

> . . . considers economy not as [would] an economist, biology not as a biologist, engines not as an engineer. In each case, its theme remains the same, namely, how systems regulate themselves, reproduce themselves, evolve and learn. Its high spot is the question of how they organize themselves (p. 11).

The next section will examine the model which cyberneticians use to explore these important properties of such diverse systems.

Cybernetic Analysis

It will be useful to begin by stipulating the necessary and sufficient conditions for a general cybernetic system. Such a set of conditions will permit the unambiguous definition of cybernetic systems and will provide the basis necessary for conceptualizing communication as a cybernetic system.

Any cybernetic system must contain:

(1) goal parameters (reference signals) set in a control center,

(2) influence exerted by the control center, i.e., an attempt to achieve the goal parameters in the part of the system being controlled,

(3) feedback provided to the control center, i.e., information regarding the effects of the output on the part of the system being controlled,

(4) comparator test conducted by the control center, yielding an error signal, and

(5) corrective action taken by the control center, if necessary (cf., Buckley, 1967, p. 172-174).

Before examining each of these five dimensions it may be helpful to sketch a familiar cybernetic system to illustrate how the five conditions constitute such a system.

An Example of a Cybernetic System

Consider a simple cybernetic temperature control system. Abstractly, the system consists of (1) a phenomenon to be controlled e.g., temperature, (2) the variables which can affect the phenomenon, e.g., a heater and an air conditioner, and (3) a control device, the thermostat. The goal of the thermostat is to keep the temperature within a specified range, say 68°-72°. The control center maintains the required temperature by operating the heater and air conditioner. It does so by changing the mode of operation of one or the other, or by leaving the mode unchanged. Thus, it can turn the heater either on or off, turn the air condition on or off, or leave one, the other, or both unaffected in their present mode (either on or off).

The decision made by the control center (as to what commands to issue to the heater and air conditioner) is dependent upon information the thermostat has about the temperature. In our example there are three possibilities: (1) the temperature is below the desired range (2) within the range, or (3) above it. Given these three states of the system, the decision format, which is being kept extremely simple for heuristic purposes, runs something like this:

(1) if the temperature is below 68° and

  (a) the heater is off, turn it on (and turn off the air conditioner if it is on)

  (b) the heater is on, do nothing (i.e., leave it on)

(2) if the temperature is within the 68°-72° range and

  (a) the heater and/or air conditioner are off, leave them off

(b) the heater and/or air conditioner are on, turn them off

(3) if the temperature is above the 72° range and

(a) the air condition is off, turn it on (and turn off the heater if it is on)

(b) the air conditioner is on, do nothing

As can be seen, the decision made by the thermostat depends upon a comparison between the information regarding the temperature and the goal set in the control center. Thus, feedback compared to the goal (reference signal) produces an error signal which determines the corrective action taken by the control center.

Let us now examine the five conditions in greater detail, using the cybernetic temperature control system for illustration.

(1) Goal parameters (reference signal) set in a control center.

The goals of the control center may be a point, a range, or a set of states. These states are the behaviors which the system, if functioning properly, will display. Goals and control are directly related for, as Beer (1959) states " . . . every system does something, and what it does can be regarded as the purpose of the machine (system). Control is the machine's [system's] strategy for achieving that purpose (p. 7)." The goals must, however, be within the range of possible states which the system can achieve. For example, if the goal for the thermostat were set at 100°-105°, but the heater was incapable of generating more than 90° of heat, then the goals of the control center would be unobtainable, control would be impossible, and the system must be considered pre-cybernetic.

(2) Influence exerted by the control center in an attempt to produce the goal parameters in the part of the system being controlled.

The control center determines the amount, degree, and/or kind of effect which those variables under its influence will be allowed to exert on the variable(s) being controlled. In that sense, the control center acts as an intervening step in the link between cause and effect. But the variables under the influence of the control center are not the only ones which affect the controlled part of the system. For example, the number of people in the room, the temperature outside the room, the wind velocity, and the extent to which windows and doors are ajar, etc., can all influence the temperature in the room--none of which are under the direct influence of the control center. The power of the cybernetic approach is the ability to deal with disturbances of the system which are not directly under its influence. The control center

> . . . not only is guaranteed to operate against a given kind of disturbance, but against all kinds of disturbance . . . In particular, it will take care of disturbances to the system whose causes are quite unknown (Beer, 1959, p. 30).

The mechanism which makes this kind of control possible is feedback.

(3) Feedback is provided to the control center, i.e., information regarding the effects of the output on the part of the system being controlled.

Two types of feedback are generally recognized: (1) deviation-counteracting or negative feedback and (2) deviation-amplifying or positive feedback. Negative feedback is defined as deviation of the controlled system away from (positively) the goal state. Information regarding this deviation is relayed to the control center which then counteracts the behavior by initiating a control operation that will have a negative (opposite) influence on the positive deviation. In our example, when the temperature deviates from the desired range either (1) the heater is turned on, or (2) the air conditioner is turned on depending upon whether the temperature has (1) fallen below 68°, or (2) risen above 72°. The steam engine governor described earlier is another example of negative feedback: as the engine goes faster (beyond the desired speed) less fuel is supplied, a counteraction by the system which keeps the engine's speed within the desired range.

It is important to note that the behavior of the system variable being controlled by negative feedback will, if plotted over time, oscillate around some value. The value around which the oscillation occurs is the equilibrium value and the range that the oscillations cover is called homeostasis. In our example, the equilibrium point may well be 70° and homeostasis 65°-75°.

Positive (deviation-amplifying) feedback also occurs in control systems. As Beer (1959) points out, positive feedback occurs when ". . . it is the function of the control mechanism to amplify a measured deviation. For example, power-assisted brakes use machinery which detects the small manual movements made, and enlarges them until the force applied is capable of stopping a vehicle in motion (p. 30)." The temperature illustration being used does not lend itself well to a discussion of positive feedback. Imagine, however, a couple sleeping in a bed with a duel-controlled electric blanket. Further, imagine that the temperature controls have been inadvertently crossed so that each person controls the temperature on the other side of the bed. If the first person gets cold during the night, he will set his control dial at a higher temperature. But since the controls are switched, he has succeeded in raising the temperature only in the other half of the bed. When his partner gets sufficiently warm, she will lower the setting on her dial, leaving the temperature on her half unaffected while lowering the temperature on the other half even more. The man, of course, responds by raising his temperature control dial to an even higher level. This oscillation continues, one half of the bed getting hotter, the other half getting colder, until the two are respectively roasted and frozen into rearranging the controls.

It is important here to make another point which will be argued in greater detail in Chapter V. The cybernetic system I am defining is not to be confused with variables that are in mutual causal relation or that form circular causal chains where the effect of a variable returns at a later point in time to influence the original variable, often through other variables. As Buckley (1967) states:

> These are not true "feedback" cycles in the cybernetic sense, inasmuch as there are no internal mechanisms which measure or compare the feedback input against a goal and pass the mismatch information on to a control center which activates appropriate counter behavior (p. 69).

In the next section I will attempt to reconceptualize the traditional circular causal framework so that it is more compatible with the cybernetic mode of analysis being developed here.

(4) A comparator test conducted by the control center which yields an error signal.

The test is a comparison between the feedback signal and the reference signal (goals) generating an error signal expressed as the difference or the ratio between the two. Powers, et al. (1966, p. 334-335), call this process the "comparator function." It should be clear that the size of the error signal is a function of the relative sizes of the two signals being compared. Further, the size of the error signal may be altered by changing the size of (1) the feedback signal, (2) the reference signal, or (3) both.

In the previous section, a distinction was made between circular causal chain (mutual interaction) systems and cybernetic systems. Circular causal chain systems such as the ecological interrelations between population size and food supply are capable of self-regulating, equilibrating behavior. But they are not capable of manifesting the "purposive goal-seeking" behavior that cybernetic systems display (Buckley, 1967, p. 69). Nevertheless, circular causal chain systems can be valuable to study and were it possible to translate them into cybernetic systems, numerous systems previously intractable to cybernetic analysis, would be open for such research. Such a translation would also serve to temper the hoary argument between the advocates for determinism and those for free will, for deterministic systems would be analyzable as if they were purposive systems.

Three conditions must be met in order that a circular causal chain system may be analyzed as a cybernetic system:

1. There must be a closed causal chain, such that influence or effect is transmitted from variable to variable around the loop.
2. One variable must be defined as a "comparator variable" and the system must be viewed from the perspective of this variable. This implies that the variable be conceptualized as a (1) discrepancy (error) produced by

comparison of (2) a desired goal (reference signal), and (3) the feedback influence from the rest of the system.

3. The comparator variable must be causally linked to a system variable such that its influence on that variable is a function of the error signal (which is defined in this system as the magnitude of the comparator variable).

Cappella (1972) provides a good example to which we shall shortly turn.

(5) Corrective action taken by the control center, if necessary.

The action taken by the control center is dependent upon the magnitude of the error signal. If the error signal is within acceptable limits the control center leaves the system unaffected. If the error signal is unacceptable, the control center takes corrective action. From this perspective, control centers can be seen to ". . . perform the sole function of bringing their feedback signals, the only reality they can perceive, to some reference level, the only goal they know (Powers, *et al.*, 1966, p. 338)."

Conceptualizing Communication from the Cybernetic Perspective

Having stipulated and explored the necessary and sufficient conditions for a cybernetic system, it is possible to attempt to conceptualize communication from within this perspective. It is assumed that each of the conditions must be fulfilled in order to have a cybernetic definition and that if all five are met, the definition will be cybernetic. Thus, viewed from this framework, communication may be conceptualized as:

(1) a goal oriented, purposive system, which

(2) emits messages to effect systemic change (achieve its goals), and

(3) must receive feedback, so that it can

(4) generate an error signal by comparison of desired and obtained effects, in order to

(5) decide whether to (a) change its goals, (b) continue in its present behavior, or (c) alter its behavior.

The definition is intended to be entirely general and assumed to apply to all communication phenomena, irrespective of "level" (intrapersonal, dyadic, small group, etc.), provided that the conditions may be met. Let us now examine each of the five conditions to determine the implications of such a definition of communication.

(1) A goal oriented, purposive system

When Berlo (1960) stated that man communicates with intent (p. 12), he was asserting that the communicative act may be viewed as goal-oriented and purposive. Many social scientists share this point of view. For example, Ackoff (1968) argues that

> Communication is an activity in which only purposeful entities can engage. Purposefulness exists only if choice is available to the entity involved and if that entity is capable of choice (p. 210).

There are, of course, objections to defining communication as purposive, some of which are logical and some empirical. Let me first examine the logical issues. Typically, purposiveness is identified with the philosophical concept of teleology--explaining an effect by its relation to some future cause. This, of course, defies the canons of explanation laid down by Mills. Woelfel (1970) argues that teleological explanations are an inheritance from Aristotle's attempt to explain the motion and substance of bodies (they sought their place in the universe); Pre-Socratic Greeks never employed such explanations. Further, Woelfel argues that the success of scientific inquiry regarding man is dependent upon producing non-purposive, i.e., deterministic, explanations.

The response to the teleological argument is to realize that purposeful (teleological) explanations need not be defined in terms of "final causes." Rosenblueth, et al. (1968), argue that

> Teleology has been interpreted in the past to imply purpose and the vague concept of a "final cause" has often been added. This concept of final causes has led to the opposition of teleology to determinism. . . . purposefulness, as defined here, is quite independent of causality, initial or final (p. 225).

Rather, Rosenblueth, restricts the definition of teleological behavior to

> . . . purposeful reactions which are controlled by the error of the reaction--i.e., by the difference between the state of the behaving object at any time and the final state interpreted as the purpose. Teleological behavior thus becomes synonymous with behavior controlled by negative feed-back . . . (p. 225).

The conclusion that is drawn from this argument is that " . . . teleology is not opposed to determinism, but to non-teleology (p. 225)."

Having separated the concept of teleology from the concept of determinism, the objection might still be raised that a purposive, choice-oriented explanation is not deterministic. This objection is met by noting that "both teleological and non-teleological systems are deterministic when the behavior considered belongs to the realm where determinism applies (Rosenblueth, et al., 1968, p. 225)." This quotation answers only part of the objection; as is implied, some purposive systems are not deterministic.

It will be helpful to note that the thrust of the objection is that it is desirable to have deterministic explanations. At least two answers can be offered to this position. Churchman and Ackoff (1968) argue that

> It is also important to note that the possibility of choice on the part of objects results from the way in which the scientist looks at the world; within the frame of reference of classical mechanics, there is no choice, but in the frame of reference of teleology, there is a choice. . . . Thus "purpose" [like "determinism"] is not found in the world; it is a fruitful scheme for studying the world. . . . we are not forced to abandon mechanics for teleology; both frames of reference are fruitful, and neither is fundamental (p. 245).

But beyond the fact that the universe may be usefully viewed from alternative perspectives is the issue of the implications of each viewpoint for our conception of man. Malcolm (1968) does not deny the conceivability of a completely deterministic explanation of man; but, having granted the possibility, he states:

> Determinism is a painful problem because it creates a severe tension between two viewpoints, each of which is strongly attractive: one is that the concepts of purpose, intention, and desire, of our ordinary language, cannot be rendered void by scientific advance; the other is that those concepts cannot prescribe limits to what it is possible for empirical science to achieve (p. 69).

Malcolm then proceeds to a comparison of a mechanistic and non-mechanistic explanation of a little boy running after a ball and concludes:

> Thus my assertion of mechanism would involve a second paradox. Not only would the assertion be inconsistent, in the sense previously explained, but also it would imply that I am incapable of having rational grounds for asserting anything, including mechanism (p. 70).

Mechanism may be conceivable, but the mechanical, deterministic condition which it imposes on man is one that is unpalatable to many social scientists. Until such a position is forced on us by irrefutable data, the purposive, intentional paradigm remains a viable alternative.

Having explored the logical issues, let us now turn to the empirical objections. The principle empirical objection to the concepts of purpose and goal as used in the social sciences is that they tend to be vague, poorly defined, and not operational. While this criticism is probably true of much research that employs the concepts, such need not be the case. Certainly the research on physical cybernetic systems includes clear, unambiguous definition of the systems goals (consider our thermostat illustration with the 68°-72° temperature range). One attempt at a rigorous formalization of the concept of purposiveness in communication is provided by Ackoff (1968):

A purposeful state(s) may be defined by reference to the following concepts and measures:

I: the individual or entity to which purposefulness is to be attributed.

C_i: a course of action; $1 \leq i \leq m$.

Oj: a possible outcome or consequence of a course of action; $1 \leq i \leq n$.

P_i: the probability that I will select C_i in a specified environment, N; that is $P_i = P(C_i / I, N)$.

E_{ij}: the probability that O_j will occur if C_i is selected by I in N; that is, the efficiency of C_i for O_j in N.

$$E_{ij} = P(O_j / C_i, I, N)$$

V_j: the value (importance) of O_j to I (p. 210).

I quote Ackoff rather extensively here simply to indicate the rigor with which the concept of purpose may be defined and utilized in communication research. Ackoff employs the above definition of a purposeful state in his development of formulas for three types of communication:

informative, instructional, and motivational. Other examples of rigorous definitions exist, and we will review one by Cappella (1972) in the section on conceptualizing a variable as a comparator.

(2) Emits messages to effect systemic change

The notion of systemic effect is a significant departure from the traditional format for exploring communication. Traditional causal analysis is concerned with the affect of one or more independent variables on a dependent variable. But the dogma of "vary the factors one at a time" does not always apply, for as Ashby (1956) says

> . . . there are complex systems that just do not allow the varying of only one factor at a time--they are so dynamic and interconnected that the alteration of one factor immediately acts as cause to evoke alternations in others, perhaps in a great many others (p. 5).

The systemic approach to the problem is to note (1) that each variable in a system may be affected by each other variable and (2) that it may require an examination of the system as a whole--the complete set of relations--in order to understand the phenomenon. The research implications, such as the use of simultaneous differential equations and appropriate time intervals for gathering data, etc., will be discussed in that section, but let me turn for a moment to the problem of holistic phenomenon.

A. N. Whitehead asserted that "the concrete enduring entities of the world are complete organisms, so that the structure of the whole influences the character of the parts (quoted in Cherry, 1957, p. 20)." This approach to reality, known as synthesis, is a radically different orientation from the analytic method of studying an object in terms of its parts. Synthesis is, however, an approach that is appropriate for studying many human processes. As Cherry (1957) says:

> Today we see an increasing concern with the synthetic, as opposed to the analytic view . . . The analysis and breaking down of social groups into individuals, or into elementary communication units, may leave untouched the main problems of sociology, which concern not the properties of the individual parts but their complex relationships, just as breaking down a man into atoms and electrons loses sight of the man (p. 20).

The synthetic approach implies that the properties of a phenomenon are irreducible to the properties of its constituent parts. As Laszlo (1972) puts it: "Wholes are not the simple sum of their parts, and heaps are (p. 28)." This suggests that the focus of study should be on the relations and interactions among the parts of the communication system.

(3) Must receive feedback

Feedback is often discussed in textbooks on communication but almost never is it treated as a necessary condition for communication. Part of the reason may be that few books treat communication from a systems perspective.

The feedback concept implies that the control variable in the system receives information regarding its affect on other system variables. The information may be obtained (1) by direct observation, or (2) by messages. (I have purposely not used the word "communication" in #2 in order to avoid the circularity which would occur by virtue of the fact that the definition of the term communication requires the concept of feedback--the term I am currently explicating.)

(4) Generate an error signal by comparison of desired and obtained effects

This aspect of the cybernetic model was identified previously as the comparator function. To illustrate how to conceptualize a communication variable as a comparator, I will review the work done by Cappella (1972) in developing a complex cybernetic model of interpersonal communication systems. In the model he constructs, Cappella attempts to determine how the degree of coordination, system consensus, perceived agreement, and persuasive communication are interrelated over time. Building upon the Newcomb (1953), Chaffee and McLeod (1969), and Scheff (1967) models of coorientation, he develops the notion of perceived consensus. Consensus is typically defined as the difference between the cognitive orientations of two persons toward some object about which they must coordinate. Cappella, however, defines perceived consensus as the difference between (1) the amount of consensus each person thinks is required for coordination and (2) the amount that he thinks actually exists between himself and the other person.

The elegance of this strategem is that it transforms a traditional variable into a cybernetic comparator variable by conceptualizing perceived consensus as a deviation from some goal state, where the goal state is that amount of consensus required for coordination. To make the cybernetic model explicit: (1) the amount of consensus a person thinks is required for coordination (i.e., the goal state) is the reference signal, (2) the amount of consensus that a person thinks actually exists between himself and another person is the feedback signal obtained from earlier communication efforts, and (3) the difference between the two, i.e., the variable "perceived consensus," is the error signal.

Furthermore, it is this variable which operates the communication system. To quote:

> . . . as this discrepancy between referent signal and perception of behavior increases, or as the size of the error signal increases, the more communication is initiated to counteract that error. Thus, communication activity acts to control levels of consensus by intending to decrease the discrepancy between perceptions of existing levels of consensus and goal states (Cappella, 1972, p. III-10).

Such a conceptualization is both powerful and precise in that it permits dynamic mathematization and testing.

(5) <u>Decide whether to (a) change its goals, (b) continue in its present state, or (c) alter its behavior.</u>

The statement that communication is purposive implies some decision making capacity in the system. Were this not true, then the connection between variables, i.e., the "control" exercised within the system, would be a matter of directly coupled, mutual causal relations. But human beings are notorious for changing their goals, and a conceptualization of communication which includes this capacity will be better than one that does not. This is not to say that a cybernetic model can account for human communication that is operating on a principle of capriciousness; by definition no model can predict the unpredictable. But if the possibility to revise his communication goals is included in the repertoire of a person's behavior (assuming the rationality of the decision in terms of continued system operation), the result is a more sophisticated model.

The discussion of the comparator variable in the last section indicated that the error signal which controls the system components was comprised of two parts (1) reference signal and (2) feedback. While it is typical to think of the reference signal as fixed, there is no necessity to do so. Thus, by the simple strategy of permitting a variable reference signal we include the possibility of changing goals without disrupting the power of the cybernetic model.

There is an important implication in this strategem which will be covered more fully in the discussion of growth in Chapter V. If it is assumed that a communication system is maintained in dynamic stability over time, then allowing the possibility of changes in goals (as well as feedback) is a clean and precise strategem for accounting for system growth (change, perhaps to a new dynamic equilibrium) from within the system, irrespective of influences that induce change from outside the system.

Examples of Cybernetic Communication Systems

The usual procedure in modeling some particular phenomenon is to examine its logic, i.e., how it operates, and then demonstrate how that logic is isomorphic with the logic of some other phenomenon, usually one that is better known and understood, which is taken as the model. The superior understanding that one has about the model can then be used to gain insights and draw inferences that might not otherwise be made about the original phenomenon. In the case of this essay, such a procedure would require an explication of the logic of communication and a demonstration of the isomorphism between it and the logic of one of the three system models.

So far, however, I have used just the reverse procedure. The cybernetic system model has been analyzed and the logic of the model has been imposed on the communication process in order to examine the power it can provide in our conceptualization of communication. That is, communication was conceptualized as if it operated according to the logic of the particular system model being examined. This means that choices were made among the alternative perspectives from which communication can be viewed, e.g., as purposive or non-purposive, with feedback or without, etc., but the choices were determined by the logic of the model being imposed. The same procedure will be used in the next two chapters.

This, of course, does not mean (1) that in studying empirical reality the logic of communication should be imposed rather than discovered, (2) that it is impossible to take a stand on what one believes to be the "true" nature of communication, or (3) that communication must be viewed from one particular logic. What it does permit, however, is an examination of the implications and efficacy of alternative conceptualizations of communication.

Having imposed the logic of cybernetics on the communication process in order to understand how it operates when defined that way, it should now be useful to examine some examples of communication to determine whether it is possible to recognize the cybernetic model in them. This will require taking a stand on at least some communication parameters (stipulated in Chapter I) that are relevant to the cybernetic model. Cushman and Whiting (1971) and Cappella (in press) have discussed the flexibility dimension; I will examine the purpose parameter.

One of the primary purposes of communication was specified in Chapter I as coordination. Consider two people who are attempting to coordinate their activities to accomplish some task, e.g., the commonplace experience of constructing a dismantled object by following a sheet of instructions. To achieve this goal, people must do two things. First, they must exchange information regarding the accomplishment of the task. Coordination may be taken to mean the limitation of message content to those messages primarily relevant to completing the task. Without the goal of coordination, the communicators are likely to say almost anything, much, if not all, of it irrelevant to the task at hand. Second in most cases, successful completion of the task requires information regarding progress. This implies that information will be generated regarding the relevance and adequacy of message content to task completion. Thus, feedback appears to be a necessary and integral part of the system.

As long as adequate progress on the task is being made, communication continues in its present state, i.e., amount and kind, etc. But should the progress fall below the expected level, it is likely that the two will take corrective action. For example, they might seek the assistance of a third party. In this part of the process it is possible to recognize the cybernetic error signal which governs the system's behavior. Thus, in this example goal (coordination), feedback, error signal, and subsequent modification all occur; the cybernetic model appears to be a good fitting model.

A second example is provided in an organizational communication research report by Berlo, et al, (1971). The institution studied had major problem with employee turnover and absenteeism. Given that the organization specified a goal of controlling turnover, and possessed a means for monitoring turnover (feedback), the report outlines communication practices which can be used to keep turnover within the desired limit. Such communication dimensions as frequency and duration of supervisor contact, frequency of communication with co-workers, etc., could be used to control the turnover problem. Though the authors did not use the cybernetic model, it is possible to recognize all of the necessary elements: (1) the purpose is the control of employee behavior, (2) feedback is available about the current level of behavior, (3) an error signal exists between the goal state and the present state, and (4) communication practices can be used by the supervisors to reduce the size of the error signal.

For the third example, consider a married couple who must coordinate their relational activities. Communication is the primary tool whereby coordination can be achieved. Each person may be viewed as a cybernetic system, or the dyad may be viewed as a "coupled" cybernetic system. One of the reasons why family discord often arises is that each person has different goals. Coordination implies the use of communication to arrive at consensus on goals.

Other examples could be provided (e.g., the control role of the mass media in society, etc.) but the above should suffice to demonstrate the applicability of the cybernetic model to communication. In each case it has been shown that if the purpose of communication is coordination or control, the cybernetic model is an appropriate model to employ.

Implications for Research

The cybernetic model sketched in the preceeding pages and the concomitant reconceptualization of communication has far-reaching and important implications for communication research. It has already been shown that to define communication from the cybernetic perspective suggests a reorientation in research questions: (1) that control of communication is fundamental, (2) that in addition to stability, growth and adaptation (to be further discussed in Chapter V) are basic, (3) that purpose and goals should be included in research, (4) that feedback is an essential process in any cybernetic system, and (5) that conceptualization of one variable in the system as a comparator variable is the intellectual strategy which permits operationalization of human cybernetic systems.

But the implications for research go beyond these substantive issues. It is also important to understand how to study a system which maintains itself over time, yet changes. Though a full discussion of these issues is beyond the scope of this essay, I will sketch what I believe to be the central issues.

One of the biggest advantages to using the cybernetic model is that with careful definition of the variables, fairly sophisticated mathematical models can be used. For example, on a relatively elementary level it is possible to develop a set of non-recursive simultaneous linear algebraic equations, the general form of which is given by Blalock (1969, p. 62):

$$x_1 = b_{12}\, x_2 + b_{13}\, x_3 + \ldots + b_{1k}\, x_k + c_{11}\, z_1 + c_{12}\, z_2 + \ldots + c_{1,n-k}\, z_{n-k} + u_1$$

$$x_2 = b_{21} x_1 + b_{23} x_3 + \dots + b_{2k} x_k + c_{21} z_1 + c_{22} z_2 + \dots + c_{2,n-k} z_{n-k} + u_2 \qquad (1)$$

$$x_k = b_{k1} x_1 + b_{k2} x_2 + \dots + b_{k,x-1} x_{k-1} + c_{k1} z_{11} + c_{k2} z_2 + \dots + c_{k,n-k} z_{n-k} + u_k$$

where x_k represents the endogenous (dependent) variables, z_k the exogenous (independent) variables, and u_k the error terms. (The reason for using different symbolism for the regression coefficients, b and c, is to maintain the endogenous--exogenous distinction.) Those acquainted with statistics will immediately recognize that this set of simultaneous equations has been constructed from multiple regression equations. Such a set of equations has the advantage of including at least some feedback terms, which make it applicable to the cybernetic model. Thus, the solution to this set of equations provides systemic information; it describes the influence on each endogenous variable of all of the other variables, including itself. Of course, the necessary and sufficient conditions for solution (identification) must be met (see Blalock, 1969, p. 65), but that task is not more difficult than meeting the assumptions underlying other complex analytic tools currently utilized in the communication discipline, e.g., analysis of variance, factor analysis, etc. (see also, Blalock, 1964).

The procedure just outlined, though relatively simple, is applicable only to static structural systems; time is not an integral part of the equation. The time variable may be included by formulating difference or differential equations. Even single equation dynamic models can be constructed with as few as two and three variables (Blalock, 1969, pp. 76-99). Should simultaneous linear differential equations be constructed then it is possible to explore several additional system characteristics:

1. An explicit solution of the equations can be obtained giving the time path that any one variable would follow from some set of initial conditions.
2. The equilibrium positions can be determined and predictions made as to the behavior of the system at or near equilibrium.
3. The conditions for stability can be obtained and predictions made as to the susceptibility of the system to external and internal perturbations.
4. Alterations in equilibrium and stability conditions can be determined as a function of changes in system constants and exogenous variables. This is known as the method of comparative statistics (Simon, 1957, p. 103; see also Blalock, 1969, pp. 100-140).

Each of these procedures has been discussed at length by other authors, but to illustrate the data collection techniques, I will review one approach outlined by Coleman (1968) for time rate of change data. If we construct a single linear differential equation of the form

$$\frac{dx_1}{dt} = a + b_1 x_1 + b_2 x_2 \ldots$$

the solution lies in being able to transform the equation to give x_{1t} (x_1 at time t) as a function of x_{10} (x_1 at time 0), x_2 and the parameters a_1 b_1 b_2. Coleman (1968, p. 441) gives the solution as

$$x_{1t} = \frac{a}{b}(e^{b_1 \Delta t} - 1) + e^{b_1 \Delta t} x_{10} + \frac{b_2}{b_1}(e^{b_1 \Delta t} - 1) x_2 \qquad (3)$$

Though this solution may look formidable, it is merely a linear equation for which regression analysis may be used on the data which has been gathered.

$$x_{1t} = a^* + b_1^* x_{10} + b_2^* x_2 \qquad (4)$$

Once the regression analysis has been performed to estimate a^*, b_1^*, and b_2^* then the coefficients of change for the original differential equation may be calculated by the following formulas:

$$a = \frac{a^* c^*}{t} \qquad (5)$$

$$b_1 = \frac{\ln b_1^*}{t} \qquad (6)$$

$$b_2 = \frac{b_2^* c^*}{t} \qquad (7)$$

where $c^* = b_1 t/(e^{b_1 t} - 1)$.

With the mathematical model articulated it is possible to gather data to calculate the time trajectory of the endogenous variable. As Coleman (1968) states:

> The integrated form of the differential equation (3) can be fitted to data to estimate parameters such as *a** and *b** (4). But the differential equation itself expresses the model, in terms of fundamental parameters of change, such as *a* and *b*. Thus the general procedure is to set up the model as the differential equation, then to use the data to estimate *a** and *b**, test the goodness of fit of the model by the amount of variance in x_{1t} explained, and then use *a** and *b** to estimate the basic parameters of change, *a* and *b*. The minimum data necessary for estimating *a** and *b** are three observations. With three values of x_1 [and x_2] taken at equal intervals of time, it is possible to write [the appropriate number of equations of form 4]. . . and thereby solve for *a** and *b** (p. 435).

The procedures just outlined are basically identical to those used for a system of interdependent variables of the form

$$\frac{dx_1}{dt} = a_1 + b_{11} x_1 + b_{21} x_2$$

$$\frac{dx_2}{dt} = a_2 + b_{12} x_1 + b_{22} x_2 \qquad (8)$$

though the researcher is certainly advised to check the mathematics before undertaking such analyses.

The rather lengthy citation from Coleman obliquely referred to the fact that data be collected at "equal intervals of time." This raises the question as to what that interval should be. Arundale (1971) has recently resolved this problem by suggesting that the maximal time interval is one half the period of the smallest period of oscillation of the fastest oscillating component of the overall process. Data plotted at this interval will reflect the entire process no matter how complex (i.e., how many constituent parts) it is.

Another research issue which seems to me to be quite important is how to analyze non-deterministic systems, for the objection may be raised that the preceding description of time rates of change require a deterministic framework. A partial answer has already been supplied for this objection by stipulating the three conditions which must be met for transformation of a purposive cybernetic system into a deterministic circular causal chain system (see, pp. 2-10), though it should be noted that there is a loss of information when this transformation is applied (cf., Cappella, 1972).

Cherry (1957) suggests that much social science research is concerned with aggregate rather than individual behavior. Thus, he argues, statistical mechanics is a more appropriate mathematical model than determinate mechanics, or more precisely it is the

> . . . mathematical methods per se of statistical mechanics which may eventually prove of some value in the study of social and other systems, rather than the (extensional) semantic relations of the method to the problems of physics (p. 25).

Wiener (1950) too, after reviewing Gibbs' formulations of statistical mechanics states that "it is with this point of view at its core that the new science of cybernetics began its development (p. 14)."

Cybernetic systems may be analyzed probabilistically. Ashby (1956) uses the behavior of insects in a pond which move back and forth among the bank, water, and streambed to illustrate that

> ... . the system composed of three populations (if large enough to be free from sampling irregularities) is determinate, although the individual insects behave only with certain probabilities (p. 167-168).

An appropriate technique to use in dealing with probabilistic rather than deterministic systems is stochastic Markov chains. This approach permits ascertainment of overall statistical determinacy, while retaining the non-determinacy of any individual state of component. Furthermore, as Coleman (1968) points out, even if the behavior of the system is viewed as discontinuous it still

> . . . may be studied by the same tool of calculas, but applied to the probability of being in a given state. In such treatment, the quantity of change is the rate of change of the probability with respect to time, dp/dt . . . (p. 432).

He develops a set of analytic procedures (completely analogous to those outlined earlier regarding deterministic continuous change) for calculating

(1) "change which is probabilistic, but fixed in time at discrete points," and (2) "change which is probabilistic, and may occur at any point in time (p. 459)." The interested reader who wishes to pursue these matters is referred to Coleman (1968, p. 459-475).

In this chapter I have stipulated the necessary and sufficient conditions for a cybernetic model and utilized these conditions to conceptualize communication from the cybernetic perspective. Of particular import have been (1) the incorporation of a scientifically valid conceptualization of purposiveness, (2) employment of feedback as an integral part of the process, (3) and definition of the comparator variable as the control center of the system. In the final section of the chapter I have attempted to indicate some of the methods whereby cybernetic data may be gathered and analyzed.

CHAPTER III

COMMUNICATION AND STRUCTURAL-FUNCTIONALISM

Structural-functionalism is the second of the three systems theories to be examined in this essay. As defined by one of its leading exponents, Robert Merton (1957), structural-functional analysis is the practice of determining ". . . those observed consequences which make for the adaptation and adjustment of a given system (p. 50)." In examining this form of system analysis, I shall again concentrate on isolating the logic of the method and be less concerned with the findings that it has generated in sociology, cultural anthropology, etc. Having reviewed the logic of structural-functional analysis it will then be possible to conceptualize communication from within that framework. As in the previous chapter, I will begin with a brief historical overview which attempts to identify the major intellectual milieu which produced structural-functionalism and conclude with a discussion of the implications for communication research which result from conceptualizing communication from this viewpoint.

For convenience in the pages which follow, I shall utilize the abbreviation "functional" (and its various forms) for the longer term structural-functional. The choice of functional over structural is not arbitrary, for the term structuralism is already used by sociologists to emphasize the study of the arrangement of societal components rather than the consequences which those parts have for the existence of the societal whole. In structuralism, the study of function is subordinated to the study of structure. In functionalism, function is the explanatory variable, while structure is demoted in importance (Martindale, 1960, p. 443).

An Historical Overview

Functionalism is probably best known in social science circles as representing a major theoretical perspective in contemporary sociology. But as Kallen (1931) points out, functionalism, which is a philosophical perspective that focuses on activity rather than structure, has affected a wide variety of disciplines (p. 523-524), e.g., philosophy, logic, biology, psychology, etc. The roots of-contemporary functionalism in sociology can be traced to two broad sources: earlier sociological thinking, and non-sociological disciplines. Since the functional approach is older in the non-sociological disciplines, it seems reasonable to start with them.

As a science, biology

> . . . is organized around the idea that each organ, or part of the system called an organism, performs a function or functions essential for the survival of the organism or of the species to which it belongs, or both; as a corollary, the principle of the interdependence of the organs is stressed. In brief, an organism is perceived as a system of functionally interrelated components (Timasheff, 1955, p. 217).

This view of the nature of biological systems has been dominant in biology for a long time. "Its distinguishing properties are found to be its concern with relations and activities rather than substances . . . transformation, dynamic patterns, and process, growth, expansion, emergence (Martindale, 1960, p. 443)."

The influence of biological functionalism on sociology can be seen in the work of Merton (1957). Prior to laying out the logic of functionalism he reviews in some detail the work of the physiologist Cannon (1939) and his use of functionalist methodology. For example, Cannon says:

> It seems not impossible that the means employed by the more highly evolved animals for preserving uniform and stable their internal economy (i.e., for preserving homeostasis) may present some general principles for the establishment, regulation and control of steady states, that would be suggestive for other kinds of organization--even social and industrial--which suffer from distressing perturbations. Perhaps a comparative study would show that every complex organization must have more or less effective self-righting adjustments in order to provide a check on its functions or a rapid disintegration of its parts when it is subjected to stress (p. 24-25).

A similar view of the nature of psychological phenomena, though of more recent origin, has had a major impact on psychological thought. In reaction to the atomistic, reductionistic philosophy which dominated early 20th century psychology, the Gestalt (configurational) position was developed which held that

> . . . any element of the mental process, if realistic understanding is to be achieved, must be studied in the context of the whole, because the meaning of every element varies in accordance with the total configuration of which it is a part (Timasheff, 1955, p. 217).

Gestalt psychology as well as functionalism in general are frequently also identified as the "holistic approach" (Cohen, 1968, p. 34). As can be seen from the above quotation, such an approach emphasizes (1) the primacy of the whole system, and (2) the interpretability of the parts only in light of the role they play in maintaining the whole system; these two characteristics of functionalism should clarify the applicability of the term "holistic" to such diverse phenomena.

Functionalism has had a major impact in anthropology, too. Radcliffe-Brown and Malinowski are generally considered the first functional anthropologists, though major functional works are also attributed to Margaret Mead, Ruth Benedict, and Gregory Bateson.

Within the discipline of sociology the earliest functionalist is generally recognized as Herbert Spencer who, as was indicated in Chapter I, drew extensive analogies between the functioning of the human body and society. Durkheim also employed the functional approach though he emphasized its distinction from causal explanations: "When, then, the explanation of social phenomenon is undertaken, we must seek separately the efficient cause which produces it and the function it fulfills (quoted in Buckley, 1957, p. 237)." Durkheim's concern pinpoints the issue of functionalism as a form of explanation which shall be discussed later in the chapter.

Contemporary sociological functionalism, according to Martindale (1960), is divided into two schools, macro-functionalism and micro-functionalism, the distinction being made in terms of the size of the unit of analysis (p. 464). Martindale classifies the work of Znaniecki, Merton, Parsons, and Homans as macro-functionalist. Micro-functionalism, also called group dynamics, is identified with the work of Lewin, Bales, Cartwright and Zander, and Festinger.

In conclusion of this brief history it may be useful to distinguish functionalism from the organic model, since (1) functionalism clearly has its historical roots in organism, and (2) organicism, especially of the Spencerian variety, was severely criticized in Chapter I. Martindale (1960) suggests that ". . . the distinctive property of the positivistic organicists was that their supersensory organisms represented actual historical configurations . . . (p. 465)." Further,

> The transition from positivistic organicism to functionalism is made when the theoretical explanations of the sociologists turn social criticism of actual historical societies or civilizations, conceived as organisms, to abstract formulation and the development of the concept of system as an explanatory principle of theory (p. 465).

More explicitly, the departure of functionalism from organicism can be seen in three unique features of functionalism:

> (1) the concept of "organic" system is generalized (without commitment in advance to the acceptance of only one type or only of vast total forms); (2) the concept of "system" is given explicit central theoretical status, becoming the point from which all analyses of structure and process are made; (3) the critical system is not identified with historical society (p. 449-450).

"Functionalism is a program of theory construction; positivistic organicism was a program of action (Martindale, 1960, p. 465-466)." The next section will examine this program of theory construction.

Structural-Functional Analysis

In this section of Chapter III, the paradigm of functional analysis will be examined. I shall begin the analysis by reviewing alternative definitions of the concept of function. Next, the logical conditions which must be met will be stipulated; following that, an examination of the empirical conditions and the research paradigm which are utilized in functional studies will be made. Finally, the section will conclude with an example of a functional analysis.

Definitions of Function

One of the tasks that is inevitably undertaken in any discussion of functionalism is an attempt to define the term "function." The concept of function has had such wide and varied usage in ordinary discourse that considerable confusion can obtain unless irrelevant alternatives are excluded. Merton (1957) clearly eliminates three standardized usages: for the functionalist, "function" does not refer to (1) a public gathering or ceremonial occasion, (2) an occupational role in an organization, or (3) a political position or official. Regarding the applicability of a fourth meaning of the term, Merton is more equivocal. In mathematics the word function refers precisely to the value of a variable that is expressed in terms of its relation to one or more other variables. In a few instances functionalists have employed this usage, but the typical usage, though similar in meaning, is considerably less precise. This fifth meaning of the term stems from biological usage and refers to ". . . vital or organic processes considered in the respects in which they contribute to the maintenance of the organism (Merton, 1957, p. 21)."

One of the clearest sociological definitions of function is that offered by Radcliffe-Brown (1952):

> The function of any recurrent activity such as the punishment of a crime, or a funeral ceremony, is the part it plays in the social life as a whole and therefore, the contribution it makes to the maintenance of the structural continuity. The concept of function as here defined thus involves the notion of a structure consisting of a set of relations amongst unit entities, the continuity of the structure being maintained by a life-process made up of the activities of the constituent units (p. 180).

It is this last definition of function which shall be employed throughout the remainder of this essay.

The Logic of Functional Analysis

The seminal essay by Merton (1957) contained a section which outlined the logic of functionalism. The items which follow stipulate those conditions which must be met in order for the analysis to be classified as functional:

(1) Certain necessary requirements of the organisms are established, requirements which must be satisfied if the organism is to survive, or to operate with some degree of effectiveness.

(2) There is a concrete and detailed description of the arrangements (structures and processes) through which these requirements are typically met in "normal" cases.

(3) If some of the typical mechanisms for meeting these requirements are destroyed, or are found to be functioning inadequately, the observer is sensitized to the need for detecting compensating mechanisms (if any) which fulfill the necessary function (p. 49).

Merton appends a fourth requirement which, he says, is implicit in the previous three:

(4) There is a detailed account of the structure <u>for which</u> the functional requirements hold, as well as a detailed account of the arrangements <u>through which</u> function is fulfilled (p. 49).

Since Merton's description is rather terse, it may be helpful to restate in greater detail the logic he outlines. In doing so, I shall draw on the formalization of functional logic developed by Nagel (1956). The logic of functional analysis requires the following:

(1) identification of the system, i.e., a set of interrelated parts (Merton calls them "items") are

identified which may be viewed as a whole. It is not necessary that all the parts be specified so long as (a) the system as a whole is identified, and (b) those parts which are necessary for the analysis are identified.

(2) specification of the environment in which the system operates. This generally means the specification of all those factors that are not a part of the system but which may affect the particular behavior of the system being studied.

(3) determination of some trait, attribute, or property of a system which is considered essential for the continuation of the system.

(4) specification of the range, i.e., the different values, which the trait *may* assume as well as the range within which it *must* stay if the system is to remain in operation. (Every trait is assumed to be variable, even if only dichotomized into present-not present.)

(5) a detailed account of how the parts (items, mechanisms, structures, etc.) collectively operate to keep the value of the trait within the limits required for the existence of the system despite other changes in the system or impinging influences from the environment.

Such a system is said to be functional, self-maintaining, directively organized, or goal-directed with respect to the trait.

Empirical Requirements for Functional Analysis

Empirical requirements may also be stipulated in addition to the logical conditions just outlined:

1. Some indication must be made of system operation. This implies (1) a set of criteria for deciding when the system ceases to exist or operate qua system, as well as (2) measurement that can reveal the current state of the system.
2. The range which the system trait covers must be measured. Linkage must be demonstrated between the required range (a subset of the possible trait range) and the continued operation of the system.
3. The several mechanisms identified in the logical analysis must be measured and their relationship with the trait must be indicated. The mechanisms are considered conceptually independent but may be empirically interdependent.
4. If any environmental factor affects the system trait it must also be measured and its relationship with the trait and system mechanisms (if there is a relationship) indicated.

The Paradigm of Functional Research

When applied to the study of human social systems, the paradigm for functional analysis implied by the logical and empirical requirements is outlined by Merton (1957), though it will be noted that some of the empirical conditions are omitted. The basic items for analysis are standardized (i.e., patterned and repetitive) social phenomena such as roles, organizations, culturally patterned emotions, etc. It assumes that people are motivated. It postulates both multiple consequences (i.e., one structure can fulfill several functions, the same function can be fulfilled by different structures) and a net balance of consequences. Functions are defined as ". . . those observed consequences which make for the adaptation or adjustment of a given system (p. 51)," though cognizance is also taken of dysfunctions and of nonfunctional (i.e., irrelevant) consequences.

A further distinction is made between two types of functions: "manifest functions" are objective consequences which are intended and recognized by people in the system, while "latent functions" are neither intended nor recognized. An item (structure) that is functional in a society may be dysfunctional to a given part of that society.

Further, a structure may be functional (or dysfunctional) on a variety of levels, e.g., individual, group, societal, cultural, etc. The assumption is made that every system has functional requirements which must be met if the system is to continue (or functional prerequisites if it is to be brought into existence). The analytic procedure requires a detailed account of the mechanisms which operate to perform these required functions. Further, a range of possible variation in the items which can serve as functional equivalents or substitutes must be taken into account. This range of variation is limited by the context in which the items occur. Finally, the concept of dysfunction, which implies strain, stress, and tension, provides the conceptual basis for a dynamic rather than static analytic framework.

An Example of a Functional System

One of the best known examples of functional analysis is Merton's (1957) study entitled "Social Structure and Anomie," the purpose of which was to determine the social and cultural structures that ". . . exert a definite pressure upon certain persons in the society to engage in non-conforming rather than conforming conduct (p. 132)." The goal of the society is its maintenance and preservation; this is achieved by the adaptation of its members to appropriate modes of behaving. Two structures exist to accomplish this goal. The first is the specification by the culture of ". . . goals, purposes and interests, held out to be legitimate objectives for all or for diversely located members of the society (p. 132)." The second structure is the specification of acceptable means of achieving these goals.

The problem in American society, Merton argues, is that there is a strong emphasis on which goals to achieve but a lack of emphasis on institutionalized means for achieving them. Thus, the approved goal in the American society is monetary success, but for many people there are no institutionalized means to achieve wealth. When sufficiently extreme, such a state of affairs produces anomie, i.e., normlessness and unstability, in the society (p. 135). Following this analysis, the remainder of the study is devoted to an exploration of alternative types of adaptation for individuals who are a part of such a society, the schema for which is presented in the following table (from Merton, 1957, p. 140).

Table 1

A Typology of Modes of Individual Adaptation

Modes of Adaptation		Cultural Goals	Institutionalized Means
I	Conformity	+	+
II	Innovation	+	-
III	Ritualism	-	+
IV	Retreatism	-	-
V	Rebellion	±	±

Five modes of adaptation are discussed and they are distinguished on the basis of (+) acceptance, (-) rejection, or (±) "rejection of prevailing values and substitution of new values" of the cultural goals and institutionalized means. In a stable society, conformity to both structures, i.e., mode I, is the most prevalent type of individual adaptation; such behavior helps to maintain and preserve the society. In the American society described above, however, another alternative may become quite widespread among individuals in the society. For example, adaptation mode IV, retreatism, is a rejection of both the cultural goal and institutional means; it is often used to typify the behavior of alcoholics and drug addicts, artists, hobos, and pariahs. Such a situation may well be dysfunctional for the preservation of the society.

If the logic of Merton's procedure is abstracted from his study, the following is the result: The system chosen for the analysis is the society (or culture). Certain mechanisms or structures (system parts) are identified whose function is to produce adaptation (the trait) on the part of individuals in the society. This individual adaptation, or a reasonably high rate of it, is seen as necessary for the preservation and maintenance of the culture. Merton shows how the malfunctioning of one of the structures (insufficient cultural legitimatization of institutionalized means) in one particular (the American) society causes individuals to seek methods of adaptation (particularly modes IV and V) which are dysfunctional to the system as a whole.

Conceptualizing Communication from the Functional Perspective

Having specified the logical and empirical requirements for a functional analysis and reviewed the methodology by which it has been employed in sociology, it is possible to impose this framework on communication and examine the resulting conceptualization. Before doing so, however, it will be helpful to clarify a problem which often leads to confusion in functional analyses. The problem arises from a failure to distinguish among the analytic levels at which a functional analysis involving communication (or any other phenomenon, for that matter) can be performed. Conceptually, it is possible to differentiate three distinct levels, and for convenience I call them the (1) "communication as mechanism", (2) "communication as trait", and (3) "communication as system" levels of functional analysis.

On the first level, communication is viewed as a mechanism which in conjunction with other parts of the system operates so as to keep some trait of the system within the bounds necessary for the system's survival. For example, a law enforcement system might use the mechanisms of communication together with physical force as a way of maintaining one of its traits, authority. The mechanisms might include each diverse phenomena as persuasive campaigns (e.g., "support your local police"), short wave radios, and megaphones at demonstrations.

The second level views communication as a necessary trait which a system maintains by mechanisms within the system. To illustrate, a social system may require that one of its traits, communication, be kept within certain bounds by mechanisms, e.g., communication rules, in order that the system continue. Such rules might include "free speech" and "slander and libel" laws, rules of interruption when talking, etc.

At the third level, communication is the system which contains parts that operate to keep a necessary trait within a required level. To again provide an example: one of the important traits of communication systems is capacity, and there are numerous mechanisms, such as non-verbal cues, which seek to keep the flow of information within the range required for the continuation of the system.

With this conceptual distinction in mind, I will now turn to a survey of communication research that has utilized the functional paradigm. [As the review will show, rather limited use has been made of this framework. The reason for this may well be that functional analysis traces its heritage to the biological and sociological-anthropological sciences while the lineage of communication runs primarily through the psychological sciences]. Following the literature review, the application of the above "levels distinction" should serve to demonstrate that virtually all of the research has been conducted on the "communication as mechanism" or "communication as trait" levels. Further, I will argue that our understanding of communication from a functional perspective will not advance until research is conducted on the "communication as system" level.

The communication research employing the functional paradigm can be organized under three areas, organizational communication, mass media, and attitude change; the review will be made in that order.

In a recent survey of the literature on organizational communication, Jacob (1971) found twelve authors who used functional categories in analyzing communication. The typical author mentioned three functions, but there were sufficient differences among the functions specified that Jacob organized them into five (unnamed) categories. The data are reproduced in Table 2.

Representative of the authors in this area are Berlo (1970) and Thayer (1961). Berlo says:

> There are three classes of uses that people make of communication: production, innovation, and maintenance of the social system in which communication occurs (p. III-9).

And Thayer states:

> Most administrative communication is conceived and designed to serve one or more of four broad functions: that of *informing* someone, that of *instructing* or *directing* someone, that of *evaluating* someone or something, and that of *influencing* another's thought or behavior (p. 133).

There are three important points to notice about the functions reviewed here and in Table 2. First, while different terms are often used, there is a fair amount of agreement among organization theorists regarding the functions performed by communication. Second, with few exceptions (perhaps Parsons and Etzioni) all of the theorists devote their writings to describing rather than explaining the functions. As Duncan (1967) says: "They stress *what* communication does in social life, but when asked *how* communication does all the things they say it does, they cannot answer (p. 243)." (Duncan's criticism was aimed

Author(s)	1	2	3	4	5
Katz and Kahn	job instructions	organizational proceedings and practices job rationale organizational goal		indoctrination of employees: social-emotional	
Redding	task	maintenance		human	
Haberstroh	control (prevent dysfunction)				
Berlo	production	maintenance			innovation
Thayer	instruct	inform	influence	integrate	
Barnard	effectiveness	efficiency			
Wickesberg	problem-solving instructions	information transmission	approval	scuttlebut	
Ackoff	inform	instruct	motivate		
Parsons	production	maintenance		management support	adaptation
Johnson(H)	goal attainment	pattern maintenance and tension management		integration	adaptation
Etzioni	instrumental information			expressive-values, norms	
	cognitive orientation				
Maslow and Argyris				self-actualization	

Table 2. Functional categories as given by twelve authors (From Jacob, 1971).

primarily at sociologists, but is, I think, equally applicable to the organizational theorists reviewed here.) For example, Berlo specifies the three functions which communication fulfills, but never identifies the mechanisms necessary to accomplish those functions.

Finally, communication is conceived of as either a mechanism or trait which fulfills a necessary function for another system, in this case, the organization. The intellectual question is never asked the other way around: what functions, if any, do organizations fulfill for communication. Thus, we learn a lot about other systems (organizations), but little about communication. A profitable organizational study where communication is the system would be to determine the function that bureaucracy fulfills in maintaining the efficiency of language.

The second area of communication research utilizing the functional paradigm is the mass media. Since a comprehensive survey of this research is already available (Weiss, 1969, p. 77-195) it is unnecessary to duplicate this work. But it is interesting to note the argument that is used for justifying the functional approach and the functions attributed to mass communication systems.

Weiss (1969) argues that

> . . . a required orientation toward the analysis of mass media effects is consideration of the crucial role played by audience dispositions. These function in two ways: to determine exposure to communications and to modulate the results of exposure. Since experimental research eliminates the first (unless information seeking is itself under study) and <u>may</u> ignore the second, its utility has been questioned by those concerned with the natural communications environment . . . (p. 116).

With this justification of the functional paradigm Weiss organizes the existing research into four functional categories: (1) filling time, typified by reading newspapers and magazines while travelling, (2) relaxation or diversion, represented by evening TV shows and movies, (3) social, where information is obtained for use in later social conversations, and (4) personal, which is a broad residual category representing a wide variety of individual needs.

Having argued that the functional approach is required for the study of certain kinds of effects and having specified four major functions of mass communication, it seems reasonable to expect a continuation of the functional analysis. But a careful review of the remainder of the article reveals a surprising number of important omissions:

(1) There is a failure to demonstrate logically and/or empirically that a given function is <u>necessary</u> for the continuation of the system.

(2) There is a failure to distinguish the level of the system being studied, i.e., is communication functional for audiences as a whole as the quotation states, for individuals as the functions themselves imply, or for both?

(3) There is a failure to specify the range within which a given function, e.g., social, must be kept in order for the system to survive.

(4) There is a failure to indicate <u>how</u> and <u>why</u> communication serves a given function in addition to the simple evidence that it does.

(5) Finally, as was the case with the organizational research, communication is viewed as a function in another system, and we end up adding very little to our knowledge of how communication itself operates.

If the Weiss review may be taken as an adequate reflection of mass media research, and if my analysis is correct, it seems reasonable to conclude that much of the mass media communication research utilizes functional terminology, but not functional analysis. In a word, it fails to meet the logical conditions necessary for the functional paradigm.

The final area of research to be reviewed is that of attitude change. Two separate functional theories of attitude change have been developed, one by Katz (1960, see also Katz and Stotland, 1959), and the other by Smith, Bruner, and White (1956). Reviews and discussions are available in McGuire (1969) and in Kiesler, Collins, and Miller (1969). Since the theories are quite similar and since the analysis I will make of one would be applicable to the other, I will discuss only the Katz version. The theory articulated by Katz (1960) is primarily a psychological theory of personality, which means that the system is defined as the individual. He states that

> Four functions which attitudes perform for the personality were identified: the adjustive function of satisfying utilitarian needs, the ego-defensive function of handling internal conflicts, the value-expressive function of maintaining self-identity and of enhancing the self-image, and the knowledge function of giving understanding and meaning to the ambiguities of the world about us (p. 204).

Thus Katz' functional theory consists of a personality system which maintains four necessary traits through the mechanism of an attitude structure. How this is accomplished is indicated in some detail by Katz, but the interesting question for communication scholars is "what part does communication play in this process?" The answer is rather surprising: communication is an environmental factor which someone outside the system (usually called the propagandist) may use to affect a person's attitudes and personality. Or, to state it the other way around, communication is not viewed as a part of the personality which is used by that system (perhaps in conjunction with attitudes) to maintain its four necessary needs. Thus, we are left with a functional theory of attitudes that does not include communication, or from a communication point of view, a non-functional theory.

Katz, of course, should not be criticized for developing a non-communicational theory; he was primarily interested in personality development. Rather, the focus of the above critique is on those communication scholars who use Katz' formulation as if it were a functional theory of communication, instead of a functional theory of personality which permits ready linkage with communication variables.

The review of functional communication research just completed revealed a number of serious deficiences in that research. First, much of the research fails to meet the logical and/or empirical requirements stipulated by the paradigm. Some might object that the foregoing analysis has too stringently applied the abstract criteria to practical research. To this objection I would reply that the relatively low fruitfulness of functional analysis in communication is due in large part to rather flagrant violations of its basic assumptions. Had similar violations occurred with the use of the paradigm in the biological sciences, it is likely that much less would be known about biological processes.

Second, it is quite clear that most of the theories and research stipulate what functions communication serves but fail to indicate how or why the functions operate as they do. While the function paradigm provides an adequate explanatory framework, most research has failed to adequately utilize it. Again, this is probably attributable to inadequate attention to the logical and empirical requirements.

Finally, for communication scholars the functional research and theorizing conducted to date is inadequate because it treats communication as a mechanism or trait in another system rather than as the system to be explained. Thus, some knowledge has been amassed about other systems and the role communication plays in them, but little is known about the operation of communication as a system, what its traits are, and what mechanisms keep it functioning.

In contrast to the rather gloomy picture just sketched, I would like to briefly review a recent article by Cappella (in press) which provides a good example of how the functional paradigm may be employed in conceptualizing communication, yet avoids many of the weaknesses of other research outlined above. The system chosen for analysis is an interpersonal communication system. The system contains the same structural parts as those outlined in the first chapter of this essay: symbols, rules, symbol users, flexibility of symbols, and intentions. In additions, two other parts are specified. The first is identified by the concept of "standardized usage," which is defined as ". . . a set of appropriate, conventional and normative symbol-referent associations and symbol combinations which are cued by the situation within which the communication takes place." The second is the concept of consensus, which refers to understanding and agreement regarding communication rules. The trait of the system which Cappella attempts to account for is accuracy, i.e., the accurate elicitation of meaning. In the analysis he indicates a range (minimal level) for the trait of accuracy which the communication system must possess in order to operate and he shows how the system utilizes the standardized usage mechanism in order to maintain the accuracy trait within that required range (above the minimal level). In addition, he specifies the functional prerequisites for the communication system.

Thus, in respect to the five logical requirements stipulated earlier in this chapter, Cappella's analysis is quite rigorous. Only in the identification of the environment is he lacking, and if, as is often done, he assumes that it is constant, the omission is not critical. With respect to the empirical requirements, however, no judgment can be rendered for unfortunately no empirical data relevant to his analysis is presented.

It would be possible at this time to make a number of suggestions regarding possible research topics utilizing the functional paradigm, but such a task falls more appropriately within the scope of the next section. In this section I have distinguished three conceptual levels for analyzing a variable from within the functional paradigm. Then a review and criticism of functional communication research was presented. Finally, an example was provided of how to adequately conceptualize communication as a functional system.

Implications for Research

Those readers who, like the author, were trained in traditional conceptual paradigms may at first exposure find it somewhat awkward or difficult to think in terms of the functional paradigm. Consequently, this final section of Chapter III will attempt to explicate the major implications for conducting communication research utilizing functional analysis. To accomplish this task, I will (1) discuss the logical and empirical requirements for gathering data, (2) suggest several functional analyses that seem potentially useful, (3) examine the relationship of functional analysis to the traditional causal paradigm, and (4) briefly review a mathematization analogous to that presented in Chapter II for cybernetic systems.

Gathering Data for Functional Systems

As was demonstrated by the literature review in the previous section, a major flaw of virtually all functional research is a failure to meet the logical requirements of the paradigm. Thus, it seems imperative that before any data are gathered a researcher should make every effort to assure that his logical analysis is valid. First, he must identify the system and its component parts and take explicit care to distinguish it from the environment. As Martindale (1960) points out, "Nothing will render a functional analysis ambiguous more quickly or completely than uncertainty as to just what, in the particular case, constitutes the system (p. 477)." Since any system is in a sense arbitrary it becomes all the more crucial to stipulate the system and enumerate its parts.

Second, it is important to be precise about the system trait being studied. Communication scholars are probably unaccustomed to thinking in terms of system traits, but once the transition is made, a surprisingly large number suggest themselves; several will be suggested shortly. Further, it is critical to specify the range in which the trait must be kept for continuation of the system. For example, if "noise" is taken as a trait of a functional communication system, then the range must be specified in which noise must be kept for survival of the system. Obviously, precision can be gained by specifying a smaller range for optimal system functioning.

Third, care must be taken to avoid confusion between system components (parts or mechanisms) and system traits (properties or attributes). Collectively, parts determine a trait(s). Thus, to use the example from the previous section, accuracy is a system attribute that is dependent upon the values or arrangement of consensus, standardized usage, rules, etc. These parts (or some subset of them) constitute the structure which determines the necessary trait, accuracy of the communication system.

Once the logical requirements have been met, compliance with the empirical conditions is relatively straightforward. Traditional data gathering procedures may be used provided that they yield results that are isomorphic with the logic. The hypotheses will be of the form: (1) values of trait T outside of range R imply non-functioning of the system, S, and (2) x amounts of mechanisms A, B, C...N are necessary to keep T in the required R. Inference testing may be applied where appropriate.

There are two additional items worth noting. First, since the notion of survival of the system and range of the trait implies variation over time, it may be necessary to gather data at several points in time. Second, it will be crucial to specify the conditions of survival for functional (self-regulating) systems. As Hempel (1968) says in a section on the empirical import of functionalist hypotheses:

> It is essential, then, for functional analysis as a scientific procedure that its key concepts be explicitly construed as relative to some standard of survival or adjustment. . . . It will no doubt be one of the most important tasks of functional analysis in psychology and the social sciences to ascertain to what extent such phenomena of self-regulation can be found, and can be represented by corresponding laws (p. 204-205).

The issues just reviewed should outline fairly precisely what procedures should be employed in studying functional communication systems. It should be additionally helpful to suggest at least a few aspects of communication which seem applicable to functional analysis.

Suggestions for Functional Research

The key to posing questions in the functional mode of inquiry is to focus on system traits. Thus, we can ask, "what traits must communication possess if it is to survive as a system and what mechanisms operate to keep the trait(s) within the required boundaries?" One example has already been provided, accuracy. Extension of this research might be possible by adding the concept of "redundancy" to the system to see whether it, in conjunction with the other mechanisms, changes the accuracy value. "Noise" is another trait which may be worth exploring. Certainly, if noise is not kept within a specified range the system cannot continue. What, then, are the mechanisms, (e.g., redundancy, shifting to alternative modes or channels, etc.) which a communication system uses to keep noise within a tolerable range?

A third trait of communication systems is capacity, which ranges from overload to underload. Note that the question "what mechanisms do systems possess to prevent overload and underload?" implies a different focus than the traditional question which asks "how do systems cope with overload?" A final suggestion is in the area of macro communication systems; the trait is integration or interconnectedness (cf., Guimaraes, 1970, and Monge, 1971). There are, of course, numerous other traits that could be identified, but the foregoing should suffice to demonstrate the fertility of the functional approach.

Functional Analysis and the Causal Paradigm

It seems appropriate to raise the issue of the difference between functional analysis and the traditional causal paradigm. The issue revolves around the fact that the functional framework is generally considered to provide a teleological rather than causal form of explanation. As Buckley (1967) indicates ". . . functionalism focuses from present to future events, and seeks to understand or explain a present phenomenon in terms of its consequences . . . (p. 76)." Such a state of affairs, he argues, is inappropriate, for

> . . . explanation must always translate "functions" into "efficient causes" (that is, prior or current states of a system rather than presumed future effects) unless some presumption of automatic adequacy or self-regulation can be supported (p. 76).

There are several important points to notice about this statement. First, while Buckley implies that there is only one mode of explanation available to scholars, philosophers generally agree that there are several modes, five of which will be discussed in Chapter V. Second, as was argued in Chapter II, teleological explanations are not inherently invalid, and there do exist forms of teleological explanation which are of scientific merit and utility. Third, the qualifying clause in Buckley's statement is critical, for functional explanation is an attempt to demonstrate the self-regulatory behavior of the system in question.

It is also worth noting that it is possible to define functional analysis in such a way that it may be transformed into the non-functional causal paradigm. Nagel (1956) in his formalization of functionalism provides an example of such a transformation and then concludes:

> The functional statement appears to be equivalent in content to either of these non-functional ones. The sole difference between them is that, while in the former we are concerned to state the consequences for a specified system of the activities of one of its parts, in the latter we stress the condition under which a certain trait or state of the system is manifested. The difference between a functional and a non-functional formulation is thus one of selective emphasis; it is quite comparable to the difference between saying that B is the effect of A and saying that A is the condition (or cause) of B (p. 251).

But despite the fact that it is possible to translate the functional, teleological explanation into a deterministic framework, there may be advantages to not doing so. As Timasheff (1955) says

> . . . the functional approach offers insights additional to the causal approach: to the "Why?" of the latter it joins the former's "What for?" Although not explaining the genesis or precise makeup of social systems, functionalism allows us to understand why certain of these elements are, or at least tend to be, persistent and why some elements occur so frequently (p. 227).

Thus, functionalism appears to be one of those rare areas in communication research where the scientist can have his philosophical cake and eat it too.

Functional and Mathematical Systems

In Chapter II a mathematical model was described for the investigation of cybernetic systems. Functional systems, under the appropriate conditions may also be described by the same model. Consider, for example, the time rate of change model

$$\frac{dx_1}{dt} = a + bx_1 \qquad (1)$$

which indicates a change in x as a function of itself. If the b coefficient is negative (and less than 1.0) the equation describes a stable equilibrium system which can be used to represent the behavior of the system trait over time. Interestingly, such a model makes no statement about causality, i.e., about those factors which make x_1 change, though it is generally assumed that there is a closed loop chain of effects where $x_1 \rightarrow x_2 \rightarrow x_3 \rightarrow x_1$ and there is an odd number of negative effects (Coleman, 1968, p. 440; closed loop causal chains will be examined in greater detail in Chapter V). In this kind of system,

> . . . the variable acts as a surrogate for all the variables involved in cycles leading back to itself--in the example, x_2 and x_3. In the same way, functional analysis takes a shortcut, letting the variable itself stand for the chain of variables which it affects that in turn affect it (Coleman, 1968, p. 440).

Thus, it is possible to develop rigorous mathematical models of functional analysis, provided the necessary conditions are met. There are two such conditions for functional phenomena. First, the system must possess a stable equilibrium point--one to which it returns when disturbed. Second, the system must be considered closed and not subject to random shocks. The variables that are part of the closed loops are considered as inside the system even though their behavior is not explained.

Coleman indicates that such mathematizations of functional systems may not help much in theory construction since they do not specify the relationships among variables within the system. This means that it fails to specify the mechanisms and their causal link to the system trait; it simply assumes that they exist in closed causal chains with the product of the bs less than 1.0. Nevertheless, such an approach may be quite useful in tracking the behavior of the system trait over time and may be a helpful preliminary step toward more rigorous explorations of functional systems.

Summary

Chapter III has explored the nature of functional systems. It began with an historical overview that traced the intellectual origins of contemporary functionalism. The logical and empirical conditions for functional analysis were stipulated and a well-known functional study was reviewed in order to illustrate the method. A crucial distinction was asserted regarding the levels of functional analysis and employed to critique the existing communication research that utilizes the function paradigm. It was argued that most of this research either failed to meet these required conditions or failed to take communication as its primary focus of inquiry. It was further argued, however, that functionalism could be a powerful explanatory paradigm provided these requirements were rigorously adhered to. An example was provided demonstrating the appropriate use of the functional paradigm. Finally, the chapter concluded by examining the major implications of functionalism for communication research.

CHAPTER IV

COMMUNICATION AND GENERAL SYSTEM THEORY

The final system approach to be discussed in this essay is "general systems theory." As defined by Miller (1965), "General systems theory is a set of related definitions, assumptions, and propositions which deal with reality as an integrated hierarchy of organizations of matter and energy (p. 193)." In examining general system theory, this chapter, like the two immediately preceding it, will be so organized as to focus on the applicability of this particular system theory to communication. Thus, the chapter begins with an historical overview followed by an explication of the logical and empirical requirements for the theory. Attention is then turned to conceptualizing communication from the general systems perspective. Finally, several implications for communication research are drawn. For convenience, GST will often be used throughout this chapter as an abbreviation for general systems theory.

An Historical Overview

The introduction of the idea of a general system theory is generally attributed to Ludwig von Bertalanffy (1968), who states that he ". . . presented it first in 1937 in Charles Morris' philosophy seminar at the University of Chicago (p. 90)." Bertalanffy (1968, p. 11-13), however, traces the germ of the idea to a number of other sources. In physics, Kohler (1927), ". . . raised the postulate of a system theory, intended to elaborate the most general properties of inorganic compared to organic systems . . . (p. 11)." The statistician Lotka (1925) also worked out a general concept of systems and applied them to population problems. The physiologists Bernard and Cannon (1939) studied the mechanisms of homeostasis and argued for an organismic conception of biology and all living systems. In philosophy, Whitehead's (1925) Science and the Modern World presented the view of "organic mechanism."

Interestingly, it wasn't until a decade after World War II that the idea of GST became rather widely diffused throughout scientific circles. This dispersion was facilitated by the establishment in 1954 of the Society for General Systems Research which began the publication of the society's yearbooks entitled, General Systems.

In order to understand the development of general systems theory, it is necessary to appreciate the intellectual problem and environment out of which it grew. The major impetus behind GST has come from biology, though a number of other disciplines have also contributed to its development. The reason for this is that biology had long chafed under the yoke of the physical sciences, attempting to explain organic phenomena by physical principles. These principles of closed, physical (mechanical) systems, which were so successful in classical science, were based on the "analytic" (as opposed to holistic) procedure described in Chapter II. The analytic procedure requires that two conditions be fulfilled. The first is that there not be interactions among the parts; the second is that the relations among the parts be linear (Bertalanffy, 1968, p. 19).

Biological systems, however, rarely meet these conditions, and in fact, biological phenomena display a number of characteristics not tractable to traditional physical analysis, among which are such features as decreasing entropy, self-directedness, organization, maintenance of a steady state at some distance from equilibrium, and equifinality (cf., Bertalanffy, 1968). Thus, biologists developed the concept of "open systems" which was " . . . an important generalization of physical theory, kinetics and thermodynamics (Bertalanffy, 1968, p. 102)", and which accounted for these characteristics of organic systems. The theory of open systems, of which living systems are a special case, was far more successful in explaining a wide range of biological phenomena; it became a unifying model capable of combining under the same general concept quite diverse phenomena.

But the theory of open systems is not the same as general system theory. Rather,

> Behind these facts we trace the outlines of an even wider generalization. The theory of open systems is a part of a general system theory. This doctrine is concerned with principles that apply to systems in general, irrespective of the nature of their components and the forces governing them (Bertalanffy, 1968, p. 149).

Despite this distinction, most writers in social science who currently discuss GST can be more accurately described as discussing the theory of open systems, for the major topics of their writings are wholeness, organization, steady state, etc., i.e., the defining properties of open systems. Part of the reason for this may lie in the fact that general system theorists often view the theory of open (as distinguished from closed) systems as the more general case. Bertalanffy (1968), speaking of open systems says:

> The prototype of their description is a set of simultaneous differential equations, which are nonlinear in the general case. . . . The methodological problem of systems theory, therefore, is to provide for problems which, compared with the analytical-summative ones of classical science, are of a more general nature (p. 19).

Interestingly, Bertalanffy holds that any technique or theory which studies phenomena as systems may be contributory to the formation of a general system theory. In this coterie of system "approaches" he places cybernetics, information theory, game theory, decision theory, topology, simulation, etc. Unfortunately, he never specifies how these various approaches can contribute to the development of GST. It is to a discussion of the development of a general system theory that I now turn.

General System Theory

Since the results of general systems theory can be of considerable value to practicing scientists in other disciplines, but the procedures used by general systems theorists to obtain these results are not, I shall make the distinction between applied GST and GST as an academic discipline. The distinction is between what other scientists do who utilize GST in their own field and what GST theorists do to obtain those results. The distinctive nature of GST as a meta-discipline seems to require this distinction, and as should become evident in the following discussion, the logical and empirical requirements of the two procedures are considerably different.

General Systems Theory as Academic Discipline

General systems theory is a relatively new academic discipline which attempts to develop an all-inclusive general theory of systems and their properties. As Boulding (1968) put it:

> General systems theory is a name which has come into use to describe a level of theoretical model building which lies somewhere between the highly generalized constructions of pure mathematics and the specific theories of the specialized disciplines. The objectives of general system theory can be set out with varying degrees of ambition and confidence. At a low level of ambition but with a high degree of confidence it aims to point out similarities in the theoretical constructions of different disciplines, where these exist, and to develop theoretical models having application to at least two different fields of study. At a higher level of ambition, but with perhaps a lower degree of confidence it hopes to develop something like a "spectrum" of theories--a system of systems which may perform the function of a "gestalt" in the theoretical construction (p. 3).

Thus, as can be inferred from the passage from Boulding and as Caws (1968) states quite explicitly, "General system theory is in fact a metatheory . . . (p. 10)," i.e., a theory about theory.

This fact is well illustrated in the recent article by Klir (1968) who indicates four levels of system generalization:

> (1) Classes of systems associated with particular scientific or engineering branches (e.g., the class of electrical circuits).
>
> (2) Classes of systems associated with two or more scientific or engineering branches (e.g., the class of generalized circuits).
>
> (3) Classes of systems associated with (a) empirical sciences (physics, psychology, etc.), (b) engineering branches (mechanical engineering, electronics, etc.), (c) abstract sciences (mathematics, linguistics, etc.).
>
> (4) The class of all systems in both science (empirical, abstract) and engineering (p. 13).

Klir then asserts that ". . . only those theories that are associated with the fourth level of generalization have the right to be called general systems theories (p. 13)." A similar position is adopted by Miller (1965) who attempts to develop a general theory of living systems.

Ashby (1958) indicates that there are two methods for developing a general systems theory:

> One, already well developed in the hands of von Bertalanffy and his co-workers, takes the world as we find it, examines the various systems that occur in it--zoological, physiological, and so on--and then draws up statements about the regularities that are observed to hold. This method is essentially empirical.
>
> The second method is to start at the other end. Instead of studying first one system, then a second, then a third, and so on, it goes to the other extreme, considers the set of "all conceivable systems" and then reduces the set to a more reasonable size (p. 2).

The first of these approaches is clearly inductive while the second is deductive. Ashby's (1956) work on cybernetics illustrates the second approach. The inductive strategy is represented by Miller (1965) who specified the logical procedure required for demonstration of a formal identity among concrete systems:

1. recognizing an aspect of two or more systems which has comparable status in those systems,
2. hypothesizing a quantitative identity between them, and
3. empirically demonstrating that identity within a certain range of error by collecting data on a similar aspect of each of the two or more systems being compared (p. 215).

There have been a number of criticisms that have been raised against these procedures, three of which will be discussed here. The first is the problem of analogy and is indicated by the first of Miller's requirements. As can be seen, the logic for the construction of a general system theory depends on drawing an analogy between similar parts of two different systems. In an early criticism of this strategy of theory construction Buck (1956) pointed to the fact (1) that analogies could be drawn between virtually any dimensions of phenomena and (2) that for every analogy that was drawn many disanalogies could also be made. In a more recent, formal analysis which compared the explanatory value of analogy, simulation, and representation, Bunge (1970) concludes that

> . . . it may be doubted whether a nontrivial theory of analogy [as distinct from simulation and representation] is possible, given the weakness of this relation. Likewise, arguments from analogy, although individually analyzable, do not seem amenable to theoretical systematization, and this for two reasons. First, because they are all invalid, so that there can be no standards of formal validity; second, because their fruitfulness depends on the nature of the case. In short, no logic of analogy seems to be possible (p. 34).

From these criticisms it would appear that a discipline built upon the logic of analogy is on rather shaky ground.

The second objection raised to general systems theory as a discipline questions the validity of establishing a universal logic to explain all phenomena. Toulmin (1969) has argued for the notion of a "field variant logic" which takes the position that various classes of phenomena in the world operate by different rather than similar logics. If Toulmin's position is correct, then the search for the universal system is doomed to failure. In a sense, general systems theory does recognize this problem, for as was indicated at the beginning of this chapter, general systems theory grew out of the inability of biological scientists to explain the behavior of organic phenomena on the basis of the logic of physical systems. Thus, there are two separate but complementary types of systems explanations, one appropriate to "closed" physical systems and the other to "open" organic systems.

Having admitted the possibility of two logics, each one appropriate to different phenomena, is it not also possible to admit the possibility of a third and a fourth? For example, Buckley (1967) states that

> . . . whereas the relations of parts of an organism are physiological, involving complex physicochemical energy interchanges, the relations of parts of society are primarily psychic, involving complex communicative processes of information exchange, and . . . this difference makes all the difference (p. 43).

Thus, it is possible that the logic of symbols, of information, is different from the logic of physical systems and the logic of organic systems. If this should prove to be the case (and it is beyond the scope of this essay to develop this position), then general system theory as it presently stands would be incapable of rendering an adequate explanation for information systems. Whether general systems theory is in principle capable of eventually providing a theory that incorporates alternative logics depends upon the interpretation of "general systems theory." If by that is meant one grand system based on one univeral logic, the answer appears to be no. If, on the other hand, the term means, as Boulding said, "a system of systems"---one system that integrates systems of alternative logics, each one appropriate for a given class of phenomena, then an affirmative response may be given.

The third problem with general systems theory as a discipline is one of utility, by which I mean the usefulness of a general system theory to the researchers in the various disciplines upon whose subject matter the general theory is built. Admittedly, this may be a narrow perspective, but of what value is it to a psychologist to know that his theoretical scheme has formal identities with those of the biologist and the meteorologist? The answer, of course, does not lie in the similarity between systems in different fields. Rather, the utility of GST is in the development of knowledge regarding various types of systems which researchers in different fields can employ irrespective of their application to other disciplines. Thus, an understanding of the properties of open systems is more useful than knowledge of Miller's (1965) cross-level hypotheses. The latter, however, can also provide useful insights and research ideas. This third problem provides a convenient transition to the second conceptualization of general systems theory, what I call applied general systems theory.

Applied General Systems Theory

The preceding section described the logical and empirical conditions for establishing a general theory of systems and discussed several serious problems in the methods that are used to achieve this goal. Further, it was argued that the procedures used by general system theorists to build their grand theory are of little utility to scholars in other, less global disciplines. In this section, therefore, I shall examine the logical and empirical requirements for the utilization of general system theory findings, i.e., I shall look at what researchers do who apply the rather large corpus of knowledge regarding systems to their respective disciplines. Thus, it will be argued that knowledge regarding the behavior and properties of alternative systems can be useful irrespective of whether a particular conception of system that is appropriate in one field is applicable to another.

The logical requirements which must be met in order to conceptualize phenomena utilizing a general systems perspective depends upon the definition of system that is employed. As we have seen, the major conceptual distinction made by GST is between open and closed systems. As would be expected, the logics of the two are different and it becomes necessary to outline a separate set of requirements for each.

In order to conceptualize a phenomenon as an open system from the perspective of GST, the following necessary and sufficient conditions must be met:

(1) identification of the components of the system. These are the parts, which together with interactions, constitute the system. Parts may themselves be systems; if so, they are subsystems of the major system.

(2) specification of relations in the system. These are the laws of interaction among the components which form the structure of the system.

(3) determination of system behavior. This implies the identification of the processes which the system engages in over time, as well as the properties which these processes imply.

(4) stipulation of the environment. In open systems this is crucial because the system's exchange with the environment, i.e., its inputs and outputs, must be explained.

(5) determination of the system's evolution. Both history and future are included here.

Item (3) indicates that the properties of the system should be identified. If the system is conceived of as open, then the relevant properties are:

(1) exchange occurs between system and environment, usually across the system boundaries. This exchange is identified as input to and output from the system.

(2) under certain conditions the system attains a steady state at some distance from true equilibrium.

(3) this steady state may be reached independently of the initial conditions and is dependent only upon the system parameters; this feature is known as equifinality.

(4) entropy may decrease (Bertalanffy, 1968, pp. 141-145).

These properties of open systems may be used to gain insight into the behavior of any phenomenon that is conceptualized as an open system. For example, if it is not possible to obtain access to the internal functioning of the system, the relationship between input and output may be used to infer the system's inner process (Ashby, 1956).

For conceptualizing phenomena as closed systems, the following logical conditions are required:

(1) a set of components, which

(2) assume a set of states (the configuration of the values of the components at a particular point in time), which

(3) change as a function of transformation(s) defined on the states such that states at a given point in time imply states at some future point in time.

The properties of a closed system are:

(1) isolation from the environment; nothing in the environment is seen as affecting the system

(2) if stable, the system attains true equilibrium rather than a steady state

(3) the system is completely determined by initial conditions

(4) entropy must increase.

Finally, it is possible to specify the empirical conditions which must be met in order to demonstrate the existence of a phenomenon as a system. For open systems, there must be

(1) measurement of all variables at a given point in time, including inputs and outputs

(2) measurement of the change in each variable as a function of all the others.

For closed systems, the requirements are similar:

(1) measurement of the state of the system

(2) measurement of the state of the system after one (or a specified number of) applications of the transformation.

The preceding rather extensive set of conditions were developed to specify what scientists must do who wish to utilize some portion of the GST model in exploring phenomena in their respective discipline. To the scientist, it should make no difference whether the aspect of the model they choose is applicable to scientists in other fields. Further, as we have seen the logical and empirical requirements for the use of GST are different from those required for its development. With the formal conditions stipulated it is now possible to explore the applicability of GST to communication.

Conceptualizing Communication from the General Systems Theory Perspective

In this section I shall examine two instances of attempts to conceptualized communication from the general systems perspective, one using the open system model, the other the closed model. While neither is entirely successful, they are suggestive of how the model may be utilized in communication research.

Communication as an Open System

One of the few conscious attempts to conceptualize the communication process as an open system is found in the work of Watzlawick, Beavin, and Jackson (1967). The focus of their efforts was on identification of the essential characteristics of ongoing interactional systems, particularly families. Using Hall and Fagen's (1968) definition of a system as ". . . a set of objects together with relationships between the objects and between their attributes (p. 81)." Watzlawick, et al. (1967) define an interactional system as ". . . two or more communicants in the process of, or at the level of, defining the nature of their relationships (p. 121)," the primary components of which are ". . . persons-communicating-with-other-persons (p. 120)." The typical system they study is a dyad, usually husband and wife.

The environment for the interaction system is then specified. Noting that the system is open, Watzlawick, et al., indicate that the environment can be taken as the family, community, other dyads, and/or the culture, but most of their analysis uses the "extended family" as the environment.

Since communication is viewed as the process of defining the relationship, two additional steps are required. The first is an indication of the states the system may assume and the second is a specification of the processes which operate the system. In regard to the first step they say,

> . . . in every communication the participants offer to each other definitions of their relationships, or more forcefully stated, each seeks to determine the nature of the relationship (p. 133).

This relationship may take one of two states: (1) "symmetrical," where there is equality between the two communicators or (2) "complementary," where one person exercises control over the other.

Concerning the second step they say,

> Similarly, each [participant] responds with his definition of the relationship, which may confirm, reject, or modify that of the other. This process warrants close attention, for in an ongoing relationship it cannot be left unresolved or fluctuating. If the process did not stabilize, the wide variations and unwieldiness, not to mention the inefficiency of defining the relationship with every exchange, would lead to runaway and dissolution of the relationship (p. 133).

Thus, Watzlawick, et al. are lead to developing the notion of relational homeostasis. That is, interacting dyads use communication to negotiate a symmetrical or complementary relationship which is accomplished by each person unconsciously accepting, rejecting, or modifying the relational offer of the other. Over time, one or the other relational state is established (relational homeostasis is attained) and the interactional system resists any attempts--both internally and externally--to change it.

A good illustration of this phenomenon is the case of husbands or wives of psychiatric patients who often experience drastic reactions (such as depression, psychosomatic attacks, etc.) when their spouse is cured. Whether the relational homeostasis is "pathological," is a separate question entirely, since both symmetry and complementarity can be either healthy or pathological.

Since the interaction system was defined as open, Watzlavick and his colleagues explore the implications of the properties of open systems for their conceptualization of communication. For example, for the property of nonsummativity they say

> The analysis of a family is not the sum of the analyses of its individual members. There are characteristics of the system, that is, interactional patterns, that transcend the qualities of individual members.... Many of the "individual qualities" of members, especially symptomatic behavior, are in fact particular to the system (p. 135-136).

The example they provide is of patients who exhibit a syndrome of anxiety, phobias, and stereotyped avoidance behavior. The symptoms, they suggest, are ". . . typically correlated with a change in the spouse's life situation, a change which might be anxiety-producing for the spouse (p. 136-137)." Thus, the wife's symptoms can be understood only in terms of her interaction with the entire family and not simply by themselves.

While not detailed, the foregoing review does cover the basic approach and main points of Watzlawick *et al.*'s attempt to conceptualize communication from the perspective of open systems. There are a number of advantages to their strategy. First, it allows them to view communication as an ongoing event, i.e., as an process with a history, present, and future. Second, they are led to examine both the (1) characteristic behavior of the system (relational homeostasis), as well as (2) those system processes which maintain it at that state. Third, knowledge of the properties of open systems help them to examine these aspects of communication; it is unlikely that they would examine the wholeness, nonsummativity, equifinality, etc., of communication had they conceptualized it from an alternative perspective.

On the other hand, there are some serious weaknesses in their work. First, there is no specification of inputs and outputs of the system, nor is there any indication of how inputs would be treated by the system. Second, while there is a description of what people do to achieve relational homeostasis, there is no explanation as to *why* this produces homeostasis. Finally, the evidence offered in support of their analysis is largely clinical and anecdotal; there is little empirical evidence to back their position. These criticisms do not invalidate their work; they simply point to some of the problems which future researchers interested in communication as an open system should solve.

Communication as a Closed System

One conceptualization of communication as a closed system was discussed in Chapter I. Specifically, Woelfel's theory of linear force aggregation proposed that the present rate of behavior be defined as the aggregate of all rates of that behavior presented to the individual through observation and symbolic communication. Since Woelfel's formulation has already been examined, I shall discuss in this section the conceptualization of coorientation developed by Monge and Farace (1972). This view of the coorientation model was not specifically developed by these authors to be a closed system view of communication. Nevertheless, in retrospect it appears to be "more closed" than most alternative views and it can be effectively utilized to demonstrate the advantages and disadvantages of closed system formulations.

The coorientation model developed by Newcomb (1953) and modified by Chaffee and McLeod (1969) postulates that two people who are discussing some object each possess two cognitive states: (1) an orientation toward the object and (2) an estimate of the other person's orientation toward the object. Pairwise juxtapositions of these four states (two for each person) produce the primary variables of the system. When one person's orientation toward an object is compared with the other person's orientation toward the object, the resultant variable is agreement. Pairing a person's orientation toward an object with his estimate of the other person's orientation toward that object yields a variable called congruency. Finally, a variable called accuracy is created by juxtaposing one person's estimate of the other's orientation toward the object with the other person's actual orientation toward the object. The five variables in the coorientation system, then are (1) a measure of agreement between the two persons, (2) two measures of congruency--one for each person, and (3) two measures of accuracy--again, one for each person. These five variables are uniquely created out of the four basic orientations and the configuration of values they possess at any point in time defines the state of the coorientation system.

The first problem for which a solution was sought was to specify how the state of the coorientation system would change as a function of change in the four primary orientations. To accomplish this, the four orientations were assigned a dichotomized value of either "change" or "no change." All possible permutations in the "change/no change" configurations were created, yielding a table containing 16 columns the entries in which ranged from none of the orientations change to all four orientations change. The five coorientation variables constituted the bottom half of the table and contained an extension of the 16 columns. In each of these columns, changes in coorientation values were indicated that would occur as a function of change introduced to one or more of the primary orientations. Thus, the table constituted a set of transformations relating change in coorientation states to change in the primary orientations. Table 3 contains the transformations.

The second problem was to determine the operator of the coorientation system, i.e., what produces changes in the system. In one sense, the transformation rules constitute the operator by unambiguously relating the two sets of variables. If this view is taken, the system may be considered closed, for it consists of a set of components, a set of states of those components, and a set of transformations which link changes in one set of variables to changes in another. The problem, however,

Table 3

Table of Transformations for the Coorientation System
(From Monge and Farace, 1972)

Differences or Changes in Orientations	"The 16 Possible System States"															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. AtoX	0	$\pm$	0	0	0	$\pm$	0	0	$\pm$	0	$\pm$	$\pm$	0	$\pm$	$\pm$	$\pm$
2. AtoBreX	0	0	$\pm$	0	0	$\pm$	$\pm$	0	0	$\pm$	0	$\pm$	$\pm$	0	$\pm$	$\pm$
3. BtoX	0	0	0	$\pm$	0	0	$\pm$	$\pm$	$\pm$	0	0	$\pm$	$\pm$	$\pm$	0	$\pm$
4. BtoAreX	0	0	0	0	$\pm$	0	0	$\pm$	0	$\pm$	$\pm$	0	$\pm$	$\pm$	$\pm$	$\pm$

Differences or Changes in Coorientation States	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A's Accuracy (2,3)*	0	0	Δ	Δ	0	Δ	?	Δ	Δ	Δ	0	?	?	Δ	Δ	?
B's Accuracy (1,4)	0	Δ	0	0	Δ	Δ	0	Δ	Δ	Δ	?	Δ	Δ	?	?	?
Agreement (1,3)	0	Δ	0	Δ	0	Δ	Δ	Δ	?	0	Δ	?	Δ	?	Δ	?
A's Congruency (1,2)	0	Δ	Δ	0	0	?	Δ	0	Δ	Δ	Δ	?	Δ	Δ	?	?
B's Congruency (3,4)	0	0	0	Δ	Δ	0	Δ	?	Δ	Δ	Δ	Δ	?	?	Δ	?

0 = no change
$\pm$, Δ = difference, change
? = uncertain

This table of transformations contains two parts: the four basic relational orientations are shown in the upper half and the five coorientations which are created by their juxtaposition are shown in the lower half. The table is designed to show how a change introduced to any combination of orientations will produce concomitant changes in the coorientation system. The 16 possible permutations of orientation change vs. no change, with the associated implications for change of the coorientation system, constitute the body of the table.

*The numbers in parenthesis indicate which subsystems must be juxtaposed to yield the relational measures.

lies in the fact that the transformations do not specify to which state the system will move from any other state.

In his early formulation, Newcomb (1953) assumed a balance or homeostatic operator, though he never specified the mechanisms which create balance. Further, when the range of coorientation states is examined, it becomes difficult to specify what constitutes balance in this system. The solution offered by Monge and Farace was to assume that the system remained in its present state until acted upon by forces inducing change. This strategy could be viewed as "opening" the system, but the attempt was made to "enlarge" the system (i.e., include additional variables) while keeping it closed.

Orientations, then, were specified to change only when a person possessing them received a message relevant to them. And messages were defined as "public orientations," i.e., public evidence regarding a person's private orientations. Thus, what was needed was a set of transformations mapping public orientations onto private ones. Under the assumption that a person's present orientation is some combination of all previous orientations (relevant to a particular object), then the next state should also operate under this combinatorial principle. Though there are alternative principles for combination, the one suggested was the aggregate. Thus, it was postulated that ". . . the effect of a message is the arithmetic mean of the person's present orientation and the value assigned to the new message (p. 17)."

When the logic of closed systems is applied to the coorientation formulation just described we obtain the following: First, the components are (1) 4 orientations (2 for each person), (2) 5 coorientation variables, and (3) messages defined as public orientations. Second, dichotomized states for the orientations and coorientations are specified, and since messages are viewed as public orientations, it is possible to treat their states in the same way. Third, a set of transformations is provided to map changes in orientation into changes in coorientation; a combinatorial principle, the aggregate, to link messages with orientations is also provided. Thus, except for the fact that changes at one point in time do not imply specific changes at a future point in time, the logic of closed systems is met rather well. Of course, the system is not entirely closed. Messages enter the system from other sources outside the coorientation dyad. Only if these were ruled out, so that the only messages allowed were those between the two people, could the system be considered closed.

The notion of a closed communication coorientation system contains some serious implications, some of which would undoubtedly be untenable to many communication scholars. The issues revolve around the properties of closed systems. First, though it is relatively easy to create a conceptually closed system, it seems reasonable to ask whether any communication system is completely isolated from its environment, or at least, sufficiently isolated that exchanges with the environment may be ignored. Second, what constitutes equilibrium for this system and what is maximum entropy? Is it a state where one person's orientations perfectly balance the others or a situation where the differences in coorientation states tend to disappear? Some would argue, as does Krippendorff (1971), that continued communication leads to structure rather than randomness. Finally, is it reasonable to assume that the behavior of this system is completely determined by its initial conditions? I would be among those who would respond in the negative.

This analysis leads to the following conclusions. First, it is possible to conceptualize the communication process from the closed system perspective. Second, such a conceptualization, if valid, entails implications for our view of communication that are in some respects untenable. Clearly, an empirical test comparing the open and closed system models would be a highly significant research undertaking, one which could have major impact on current ways of thinking about communication. It is to this and other suggestions for research that I now turn.

Implications for Research

One of the striking incongruities regarding the systems model is that though it is frequently cited in communication texts, journal articles, and dissertations, very little empirical research has been conducted to ascertain the efficacy of the model. Thus, in this section I would like to (1) suggest several communication topics which seem ripe for systems research, and (2) sketch a research example utilizing the systems paradigm.

Suggestions for Systems Research

Virtually any of the traditional areas of communication research can be studied from the systems paradigm. For example, in persuasion research it is customary to examine the effect of several variables, e.g., source credibility, order of arguments, persuasibility of recipient, etc., on the change in a person's attitude toward the topic. From a systems perspective, the question is asked, "How does each of these variables effect all the others?" For example, does a person whose attitudes are changed by the persuasive attempt become more persuasible? And does a person who changes his attitude toward a topic also change his estimate of the credibility of the source? Thus, viewed from this perspective persuasion is a complex system of interacting variables which affect each other and over time produce a whole set of changes in the variables, only one of which is attitude change.

Another area is mass media research. A typical question may be to seek the relationship between a news event and media coverage. Traditionally, the question might be asked, "How does the nature of the news event determine the media coverage?" Or someone might see the question from the alternative perspective and ask, "How does the nature of the media coverage determine the news event?" From the systems view the question becomes "How does each effect the other?" In the case of a riot, for example, the attempt should be made to determine how people's behavior affected the reporter's behavior and how the reporter's behavior effected that of the rioters.

Research using the coorientation model has already been shown to lend itself to systems research in small groups. Katz and Kahn (1966) provide suggestions and examples of how it can be incorporated in the area of organizational communication, as do Miller and Rice (1967). Though many other suggestions could be provided, the above should suffice to demonstrate the wide research potentials of the systems framework.

An Example of Systems Research

In a recent book Blalock (1969) outlines one approach to research that utilizes the systems paradigm of theory construction. It includes the following steps: First, appropriate variables are selected from a review of the literature in the field, or from the scientist's experience

in the area. Second, the relation between each pair of variables is specified (including the direction of causality) e.g., as _a_ increases _b_ decreases.[1] Third, a choice is made as to which of the variables is to be explained, i.e., which are endogenous (dependent) and which are exogenous (independent). Fourth, a regression equation is constructed for _each_ endogenous variable as a function of all other variables in the system. Some of the other variables will not be directly related to a particular endogenous variable, and hence their coefficients will equal zero and they will drop out of the equation. Finally, a solution is sought for this _system_ of (linear) equations by analyzing each equation separately and combining the results to provide a theoretic interpretation. As was noted in Chapter II, this approach is appropriate for both static and dynamic theoretical formulations, and for simple recursive models as well as more complex interactive models.

To illustrate, I will examine a set of propositions offered by Collins and Guetzkow (1964) to see how they could be developed into a systemic theory. I have selected six of the statements and reworded some of them slightly. They are as follows (the numbers are those used by Collins and Guetzkow): For any person in a group,

9.2 The greater his initiation of communication, the greater his reception of communication.

9.3 The higher his power status, the greater his initiation of communication.

---

[1] Zetterberg (1966) specifies the dimensions of a relation which must be specified in any proposition: a relation must be (1) reversible or irreversible, (2) deterministic or stochastic, (3) sequential or co-extensive, (4) sufficient or contingent, (5) necessary of substitutable. Zetterberg also offers a 6th dimension, the interdependent relation which is a combination of the reversible, sequential, and contingent attributes.

9.4-A The higher his power status, the greater his reception of communication.

9.5a The greater his proximity, the higher his initiation and reception of communication.

9.5c The higher his socio-economic status, the higher his initiation and reception of communication.

9.6 The higher his initiation and reception of communication, the higher his uniformity of opinion with other members in the group (p. 187).

These six propositions specify relations among six variables: socio-economic status, power status, proximity, initiation of communication, reception of communication, and uniformity of opinion. Three of these are endogenous variables: initiation of communication, reception of communication, and uniformity. Hence, we need to establish three equations which will define the changes that will occur in these three variables as a function of the other variables in the system. Stated in verbal form, the regression equations take the following form:

1. Initiation = socio-economic status + power status + proximity
2. Reception = socio-economic status + power status + proximity + initiation
3. Uniformity of opinion = initiation + reception

The solution of this system of simultaneous recursive equations will permit statements regarding the effect of all of the exogenous variables on each of the endogenous variables. Thus, the interrelations among all of the variables may be determined. Should we wish to trace the behavior of this system over time to determine its equilibrium states and reaction to perturbations, then we simply build in time as a variable, and convert the static regression equations to dynamic difference or differential equations.

With this theoretical formulation clearly specified, the research procedures are fairly straightforward. First, data must be gathered on all six variables at some point in time. Second, standardized regression coefficients must be calculated between each endogenous and exogenous variable. Finally, the mathematical solution to the set of three equations is obtained and the data are used to estimate the parameters of the equation. With this information, it is possible to study:

(1) the rate of change of any of the three endogenous variables as a function of all the other variables (and time),

(2) the equilibrium position of the system, and

(3) the stability of the system and its susceptibility to perturbations.

Clearly, such information provides powerful and useful insights into the nature of the communication process, insights which are not available in the traditional non-systems paradigm.

Two final points can be made. First, verification of the theory is relatively easy in this paradigm. A second wave of data is gathered at a later point in time and the analysis of this second wave data is compared with the predictions made by the model on the basis of the original data. Second, should an open systems model be used instead of the closed system implied by the above equations, Bertalanffy (1968, p. 126) suggests the use of partial differential equations. While this considerably complicates the mathematics, it does provide a completely valid method for dealing with open systems.

Summary

The subject of this chapter has been general systems theory and its applicability to communication. After a brief historical overview, the distinction was drawn between "GST as an academic discipline" and "applied GST which is of importance to communication." Logical and empirical criteria were stipulated for conceiving of any phenomenon as either an open or a closed system, and conceptualizations of communication from both perspectives were provided. Finally, suggestions for communication research were offered and an example was given of how to use the systems paradigm in conducting research.

CHAPTER V

COMMUNICATION AS A COMPLEX, ADAPTIVE SYSTEM

The previous four chapters have examined how communication operates if it is conceptualized from a systems perspective. In order to keep the analysis as uncomplicated as possible, the simplest, stable form of each of the systems models was examined. But most systems in the real world are not characterized only by simplicity and stability. Rather, they are complex, adaptive systems. Thus, in this final chapter, I will turn to an examination of the concepts of complexity and adaptation as they apply to communication systems. The essay will then conclude with a comparison of the three systems paradigms with each other, and with the more traditional paradigm of scientific explanation.

The Complexity of Communication Systems

Conceptualizing communication as a system generally implies a significant increase in the complexity of analysis necessary for description and explanation. As Beer (1959) says

> A system consists of *n* elements. Before we started talking about systems, this would have meant *n* investigations to find out what this set of things was like. Once we declare the set of things to be a system, however, there are not only the *n* elements themselves to examine, but *n* (n-1) relations between the elements to be examined (p. 10).

He provides an example:

> Think of a system with only seven elements. This has forty-two relations within itself. If we define a state

> of this system as the pattern produced in the network when each of these relations is either in being or not in being (which is not a very detailed account of the relationships), then there will be 2^{42} different states of the system. This is a fantastically large number: more than four millions of millions (p. 10, 11).

Traditionally, science has avoided the study of such complex systems. Ashby (1956) puts it this way:

> Science stands today on something of a divide. For two centuries it has been exploring systems that are either intrinsically simple or that are capable of being analyzed into simple components.... But science today is also taking steps towards studying "complexity" as a subject in its own right (p. 5).

<u>A Typology of Complexity</u>

Rapoport and Horvath (1968) characterize the complexity of systems by a trichotomized typology:

> (1) organized simplicity--a complex of relatively unchanging components linked by a strict sequential order or linear additivity, without closed loops in the causal chain,
>
> (2) organized complexity--a collection of components interconnected by a complex net of relations that may be nonlinear and include closed loops in the network, and
>
> (3) chaotic complexity--a vast number of components that do not have to be specifically identified and whose interactions can be described in terms of continuously distributed quantities or gradients [see also Buckley, 1967, p. 38].

Organized simplicity is the approach of classical mechanics (i.e., classical physics) and is appropriate only if the interactions in the system are trivial (i.e., the system is additive). It is a description of the type of phenomena to which the mechanistic model is appropriate; Woelfel's theory of linear force aggregation is a good example. At the other extreme, chaotic complexity is the approach of statistical mechanics;

it is probabilistic rather than deterministic and allows for explanation of phenomena with a large number of unidentified components, e.g., the behavior of gases. I know of no examples where this technique has been used in communication research.

Finally, organized complexity is representative of the organic model. The emphasis is upon the holistic properties of nonlinear, complex networks. It utilizes the tools of cybernetics and topology. It is this third approach which will be useful in dealing with complex communication systems; it is the subject of the next section.

Dealing with Complexity

Communication scholars frequently study the characteristics and properties of communication networks which consist of a large number of components and the specified relations among them (see Monge, 1971). Thus, by Rapoport and Horvath's typology, they may be viewed as organized complexity. The flow of information through such networks, and other properties of the system are difficult to define without some kind of organized restriction on the possible relations.

Let me construct an example (cf., Katz and Kahn, 1966, p. 225). Imagine a group of 60 people. If everyone talks to everyone (and the relation is reciprocal) the possible number of communication channels in this system is

$$n(n-1)/2 = (60x59)/2 = \underline{1770}$$

Now if constraints are placed on who talks to whom such that the 60 people are organized into 12 groups of 5, then <u>each</u> group has (5x4)/2 = <u>10</u> connections and since there are 12 groups, there are 120 connections <u>within</u>

all 12. Now, the 12 groups are isolated from each other, so if one person is allowed to speak as a representative for each group, the total number of possible channels among the twelve groups is (12x11)/2 = 68. Adding together the total number of possible connections within and among the 12 groups yields a overall number of 120 + 68 = 188 channels. Comparing this figure with the unconstrained, unorganized number of 1770 possible channels, the reduction in complexity amounts to 1770 - 188 = 1582 channels. Thus, the determination of constraint and organization is one important method of dealing with complexity.

In the example just provided the complexity was directly observable. In some cases, however, the internal connections cannot be observed by the researcher. If this situation obtains, another alternative for dealing with complexity is available. Cyberneticians call it the black box approach. Alexander (1964) provides a good example:

> Imagine a system of a hundred lights. Each light can be in one of two possible states. In one state the light is on. The lights are so constructed that any light which is on always has a 50-50 chance of going off in the next second. In the other state the light is off. Connections between lights are constructed so that any light which is off has a 50-50 chance of going on again in the next second, provided at least one of the lights it is connected to is on. If the lights it is directly connected to are off, for the time being it has no chance of going on again and stays off. If the lights are ever all off simultaneously, then they will all stay off for good, since when no light is on, none of the lights has any chance of being reactivated. This is a state of equilibrium. Sooner or later the system of lights will reach it (p. 39).

Alexander then considers three possible states of the system. The first is that there are no interconnections. If this is true, the system reaches equilibrium after two seconds. Such a situation hardly constitutes the type of ongoing system discussed in this essay. The second situation is where there are ". . . such rich interconnections between lights that any one light still on quickly rouses all others from the off state and puts them on (p. 40)." Such complexity will take 10^{22} years to reach equilibrium! The third case is equivalent to the subsystem constraint imposed in the communication example. Ten subsystems of ten lights each are created, each subystem being richly interconnected within but independent of the influence of other subsystems. The system thus constrained reaches equilibrium in approximately 2^{10} seconds, or 15 minutes. The conclusion should be fairly obvious:

> No complex adaptive system will succeed in adapting in a reasonable amount of time unless the adaptation can proceed subsystem by subsystem, each subsystem relatively independent of the others (p. 41).

Adaptation will be examined in the next section; the important thing to notice from this conclusion regarding the problem of complexity is that knowledge of the organization of the elements as reflected in the constraints of the subsystems is the key to understanding the system.

But what if, as suggested earlier, the internal organization is not directly observable? Alexander suggests that

> The greatest clue to the inner structure of any (internally unobservable) dynamic process lies in its reaction to change. . . . imagine that every once in a while one switch gets switched on by an outside agent, even though no others are on to activate it. By waiting to see what happens next, we can easily deduce the inner nature of the system, even though we cannot see it directly. If the light always flashes just once, and then goes off again and stays off, we deduce that the lights are able to adapt independently, and hence that there are not interconnections between lights. If the light activates a few other lights, and they flash together for a while, and then switch themselves off, we deduce that there are subsystems of interconnected lights active. If the light flashes and then activates other lights until all of them are flashing, and they never settle down again, we deduce that the system is unable to adapt subsystem by subsystem because the interconnections are too rich (p. 44-45).

The procedure just described is an excellent example of what was referred to earlier as the black box approach. A black box consists of any system whose internal operations are unobservable but whose input and output states are known. The investigator analyzes a black box system by recording a protocol of input and output states over time. ". . . all knowledge obtainable from a Black Box (of given input and output) is such as can be obtained by recoding the protocol . . . (Ashby, 1956, p. 89)." This recoding is a search for patterns which allow the investigator to create the set of transformations which uniquely describe the system. Thus, the black box approach enables the investigator to obtain information about the organization of the subsystems which constrains the complexity of internally unobservable systems.

Summary

This section has briefly examined the problem of the complexity of communication systems. A typology of system complexity indicated that communication be treated as a system of "organized complexity"--a collection of components interconnected by a complex net of relations. Two methods were provided for dealing with complexity, one applicable to internally observable systems, the other method for those systems which are internally unobservable.

The Adaptation of Communication Systems

The majority of system theories in social science and communication are based on the concept of balance, i.e., equilibrium or steady state. For example, Parsons' (1951) theory of action, Merton's (1957) functionalism, Heider's (1958) balance theory, Newcomb's (1953) strain towards symmetry, Osgood and Tannenbaum's (1955) congruity principle, and Festinger's (1957) cognitive dissonance all share the same characteristic of maintaining some system property within a necessary range or alternatively, the balancing of opposing forces. To accomplish this, the theory must specify the mechanisms which stabilize, maintain, and preserve the structure of the social psychological, or communication entity being described. Thus, the emphasis in these systems is on structural permanence.

A Model of Morphogenesis

But communication and social systems, unlike organic systems, don't have a fixed, required structure. Rather, they have fluid, changing structures; they are, as Buckley (1967) says, ". . . characterized primarily by their propensity to change their structure during their culturally continuous 'life-time' (p. 31)." Thus, any description of a communication system which accounts only for structural preservation is insufficient. An adequate theory must also specify those processes which cause the system to change. This emphasis on change is important because it permits the study of communication as a complex adaptive system rather than a static, enduring structure. Living systems, communication included, grow and develop, decay and disintegrate, and a full understanding of the communication process requires knowledge of how the system will change over time.

Buckley (1967) adopts the terms morphostasis and morphogenesis and says:

> The former refers to those processes in complex system environment exchanges that tend to preserve or maintain a system's growth form, organization, or state. Morphogenesis will refer to those processes which tend to elaborate or change a system's given form, structure, or state. Homeostatic processes in organisms, and ritual in sociocultural systems are examples of "morphostasis;" biological evolution, learning, and societal development are examples of "morphogenesis (p. 58-59)."

Communication examples also abound. The grammar and syntax of language, the communication networks in an organization, the degree of "cognitive dissonance" which a person will tolerate are often in a process of change.

A method to account for morphogenesis has been suggested by Maruyama (1968). Using the cybernetic model he indicates that "deviation-amplifying mutual causal processes" can explain system adaptation. It is this model that I will use to account for the growth and decay of communication systems, but some preliminary explication and modification are necessary.

As indicated in Chapter II, the focus of cybernetics has typically been upon mutual causal systems where ". . . each element has an influence on all other elements either directly or indirectly, and each element influences itself through other elements (Maruyama, 1968, p. 312)." The means by which an element influences itself is a closed causal loop, i.e., a chain of causal relations which return to the initial point of influence. This means, for example, that a change in A causes a change in B which then causes C to change which finally causes another change in A. These loops are referred to as feedback loops because they give the initial variable (in our example, A) information about its effect on the other variables in the system. This information, in turn, alters the value of the initial variable, and the nature of that change is a function of whether the feedback is positive or negative. According to Maruyama, if the feedback loop is negative, then an increase in the initial variable will produce a decrease in that value at a later point in time due to the net influence of the individual links in the loop. Likewise, in a negative feedback loop, a decrease in the initial variable will later produce an increase in that variable. Thus, it can be seen that negative feedback loops <u>counteract</u>

the behavior of the initial variable, on each cycle changing increases into decreases or decreases into increases, and thus causing the initial variable to oscillate around some value.

Positive feedback behaves quite differently. An increase in the initial variable will later produce an increase in that variable, which will then amplify another increase around the loop until the system exceeds its capacity for further increases. Likewise, a decrease in the initial variable will produce a decrease in that variable at a later point in time and the system continues to produce decreases until it exceeds its capacity to decrease further. Positive feedback is generally referred to as deviation-amplifying because an initial change in magnitude is followed by further changes in the same direction rather than counteracting changes.

For the purposes of this discussion, the central point of Maruyama's article is that negative feedback produces changes in the system which tend toward stability of the system and positive feedback produces changes which cause the system to tend toward values or states in which it has never before existed. Thus, deviation-amplifying positive feedback loops are mechanisms which produce morphogenesis.

The question remains as to how one determines whether a causal chain is positive or negative. The notion of a causal chain implies that between each pair of variables, (i.e., for <u>each link</u> in the chain) there is a describable mathematical relation, e.g., a positive or negative correlation. The rules of determination used by Maruyama are (1) a loop with all positive correlations is deviation-amplifying, and (2) ". . . a loop with an even number of negative influences is deviation-amplifying, and a loop with an odd number of negative influences is deviation-counteracting

(p. 312)." This is equivalent to the algebraic rules for determining the sign of factored terms.

Axiomatic Deductive Theory

An alternative approach which also attempts to determine implied relationships and utilizes the algebraic sign rules is provided by Zetterberg (1966); it is generally referred to as axiomatic deductive theory. I will discuss Zetterberg to show (1) the equivalence of the Maruyama and Zetterberg approaches, (2) the necessary conditions for determining whether a feedback loop is positive or negative, and (3) how the sign rules applied to the individual relations are by themselves inadequate to fully understand the nature of the feedback process.

Axiomatic deductive theory states that for any two propositions that share a common middle term, a third proposition may be deduced. Thus, from two postulates of the general symmetrical non-causal form:

> The greater the A, the greater the B
>
> The greater the B, the greater the C

Zetterberg deduces the conclusion:

> The greater the A, the greater the C

It is important to remember that the relation asserted between two variables of a postulate can be either direct or inverse. A direct relation states that when the first variable changes its value in a given direction (e.g., it increases), the second variable will change in the same direction (it will also increase). For example, the postulate, "if the amount of communication about a topic increases, the amount of accuracy of the discussants will also increase," asserts a direct relation. The inverse relation, on the other hand, states that when the first variable changes (increases), the second variable will change in the opposite direction (decreases). For example, the postulate, "if the amount of communication increases, the amount of competition between the discussants will decrease," states an indirect relation. When two postulates are viewed together as premises, three combinations of relations can obtain: (1) two direct statements, (2) a direct and an inverse statement, or (3) two inverse statements. Like Maruyama, Zetterberg uses the algebraic sign rules for determining whether the deduced relation is direct or inverse, though it should be noted that Zetterberg employs them for symmetrical, non-causal propositions while Maruyama uses them for asymmetrical causal relations.

Logical and Empirical Conditions

Costner and Leik (1971) critique Zetterberg's approach on both logical and empirical grounds. Their primary empirical criticism is that the sign rules hold only under certain conditions, specifically, when

$$r^2_{AB} + r^2_{BC} > 1.0$$

The purpose of this stipulation is to ensure that the sign rule will yield valid conclusions; it is required because of the relationships among the three variables. Empirically, the relationship between the variables in the deduced proposition, A and C, is not reflected in the simple correlation, r_{AC}. Rather, the relationship is contained in the partial correlation, $r_{AC.B}$, and meeting the required condition has the effect of controlling for the influence of the intervening variable, B. Obviously, the condition is quite stringent for social science data, for it requires higher correlations than are typically obtained.

Given the difficulty of meeting the empirical criteria for the validity of the sign rule, a modification of the logical criteria is required. Costner and Leik specify a set of sufficient conditions which validate the sign rules irrespective of the magnitude of r_{AB} and r_{BC}:

> i. postulates are stated in asymmetric causal form;
>
> ii. the common variable in the two postulates is prior to one but not to both of the other two variables; and
>
> iii. a "closed system" is assumed, i.e., it is assumed that there is no connection between the variables in the postulates (otherwise, the assumption of uncorrelated error terms would be unwarranted and the propositions would not imply a zero partial) (p. 60-61).

In a recent review of Costner and Leik's three sufficient conditions, Bailey (1970) concurs that ". . . the assumption that [all three of] the causal requirements have been met enables one to make valid predictions regardless of the magnitude of *r* involved (p. 56)." However, he also notes that ". . . the lower the *r*, the less likely it is that the assumptions have been met (p. 56)." Further, Bailey distinguishes between two types of axiomatic theory: explanatory, in which only the deduced conclusion (not the postulates) is empirically tested, and synthetic, in which both postulates and conclusion are tested (p. 58). Having made this distinction he then asserts that Costner and Leik's sufficient conditions are valid only for synthetic requirements. For explanatory theories, he argues, postulates should be stated in reciprocally causal rather than asymmetric form (p. 61).

Comparison and Illustration

It was stated earlier that the Zetterberg and Maruyama approaches appear to be basically equivalent. The reason for this assertion becomes apparent when the deductive chain is expanded and transformed into a closed loop. As before, such a closed loop will show the effect of the initial variable on itself. To accomplish this transformation, it is necessary to develop a set of propositions such that the causal variable of the first proposition and the consequent variable of the last proposition refer to the same variable but at different points in time. Thus, in logical format:

an increase in A_t produces an increase in B

an increase in B produces an increase in C

. . . .

. . . .

. . . .

an increase in N produces an increase in A_{t+1}

$\therefore$ an increase in A_t produces an increase in A_{t+1}

where A_{t+1} is understood to mean A at a later point in time. In empirical (correlational) terms this is equivalent to the partial correlation between A_t and A_{t+1}, i.e., the effect of A upon itself:

$$r_{A_t A_{t+1} \cdot (B \ldots N)}.$$

A simple example should help to illustrate the procedure. Assume for the present that an explanation is being sought for the communication behavior of two people who hold considerably divergent views on a subject but are not initially aware of the difference. I will employ three variables and state three postulates among them. The variables are:

A = communication regarding a topic of disagreement,

B = coorientation accuracy, i.e., the ability to predict the other person's position on the topic, and

C = attraction for the other person.

For the sake of the illustration assume that the three postulates are true. Then, for any two people:

An increase in A_t produces an increase in B

An increase in B produces a decrease in C

A decrease in C produces a decrease in A_{t+1}

$\therefore$ An increase in A_t produces a decrease in A_{t+1}

That is, an increase in communication at time t produces a decrease in communication at time t+1, or people who discover that they disagree on a topic will tend to discontinue their communication on that topic. By fulfilling the three conditions stated earlier (i.e., propositions stated causally, the common variable in each step of the chain prior to one but not both of the other variables, and an assumed closed system), the sign rules hold, and since there are two direct postulates (the first and third) and one inverse postulate (the second), the conclusion is that the loop is negative (because there are an odd number of negatives) and thus deviation-counteracting.

The empirical measure for determining this causal loop (in correlational terms) is:

$$r_{A_t A_{t+1}} \cdot (B,C).$$

Having demonstrated that the two approaches just discussed are equivalent, it seems reasonable to assert that the sufficient conditions applicable to one should apply equally well to the other. Thus, I will consider that the sufficient conditions specified for the applicability of the sign rule (as developed by Costner and Leik and modified by Bailey) will apply equally as well to Maruyama's approach as to the Zetterberg procedure for which they were originally articulated.

A Typology of System Change

I now turn to the problem of determining the specific behavior of a feedback loop. The distinction made by Maruyama was simply that of deviation-amplification or counteraction. I would argue that this distinction is inadequate because (1) it fails to logically exhaust the possible system behaviors, and (2) it does not employ all of the available empirical information.

Let me first examine the logical aspect. For a complete description of system behavior it is necessary but not sufficient to know whether a loop will change (deviation-amplify) or maintain its present value (deviation-counteract). In addition, it is necessary to know whether a change will lead to a new level that the system can maintain or be destructive of the system. Thus, it is necessary to know about the stability of the system. Following Blalock (1969, p. 82), I suggest that the following four feedback situations, which may characterize a system plotted over time, logically exhaust the possibilities:

I. Deviation-amplifying loops

   A. Unstable positive feedback

      1. an initial increase leads to the eventual destruction of the system as described by mathematical explosion

      2. an initial decrease leads to eventual destruction by decay

   B. Stable positive feedback

      1. an initial increase leads the system to a new stability point at a higher level

      2. an initial decrease leads to a new stability point at a lower level

II. Deviation-counteracting loops

A. Unstable negative feedback

1. an initial increase/decrease leads to eventual decay

B. Stable negative feedback

1. an initial increase/decrease leads to restoration and maintenance of the equilibrium value

It is now important to examine the empirical conditions which determine the behavior specified by the above typology. They are quite straightforward: it is necessary to know (1) the sign of the loop, (2) the magnitude of the product of the standardized correlation coefficients, and (3) the direction of the initial deviation. Each will be examined in turn.

(1) The sign of the loop indicates whether the loop is deviation-amplifying or counteracting. It is determined by the application of the algebraic sign rules already discussed provided the necessary conditions for their use have been met.

(2) The magnitude of the product of the standardized correlation coefficients (B's) determine the stability of the loop. If the product is greater than 1.0, the loop is unstable; if less than 1.0, stable. The standardized correlation coefficients must be used because the products of simple correlations can never exceed 1.0.

(3) The direction of the initial deviation indicates for deviation-amplifying loops whether (a) the unstable positive feedback will lead to explosion or decay, or (2) the stable positive feedback will lead to stability at a higher or lower level.

Implications

The rather intricate analysis of the preceding pages leads to a useful and powerful conclusion: For any set of mutual causal communication variables, it is possible simply by inspection of three empirical conditions to determine which of the possible types of behavior the system will assume. More precisely:

1. If the sign of the loop is positive, and the product of the Bs is greater than 1.0, any deviation of the system from its equilibrium point will lead to its destruction.

2. If the sign of the loop is positive and the product of the Bs is less than 1.0, an initial deviation of the system from its stabilization point will lead to the establishment of a new stabilization point at a different level.

3. If the sign of the loop is negative and the product of the Bs is greater than 1.0, a deviation of the system from its equilibrium position will lead to its destruction.

4. If the sign of the loop is negative and the product of the Bs is less than 1.0, any deviation of the system from its equilibrium or steady state position will be countered by a move in the opposite direction until the equilibrium value is restored.

It is immediately obvious by inspection of these four alternatives that only one of them leads to morphogenesis which is non-destructive to the system: alternative number two. Thus, for a mutual causal system to be capable of change (growth or decay) as well as homeostasis, the sign of the loop must be positive and the product of the Bs must be less than 1.0.

If this analysis is applied to the communication example described earlier, several things become apparent. First, despite the fact that the magnitude of the Bs is unknown it can be ascertained that since the loop is negative, the amount of communication in the system cannot undergo stable change. Second, if the product of the Bs proves to be greater than 1.0, change will lead to destruction of the system. Alternatively, if the product is less than 1.0, the system will oscillate around its equilibrium point. Thus, an initial increase (or decrease) in the amount of

communication regarding a topic of disagreement will lead respectively to either (1) cessation of communication or (2) restoration of the original amount of communication.

The question which immediately comes to mind asks, "Is it possible to change a morphostatic theoretical formulation (and subsequent empirical investigation) so that it is morphogenetic?" To this I would venture a cautious affirmative. Two alternatives seem possible. First, adding a negative link to a negative loop will make it positive. Second, adding a link which has a low enough r will serve to attenuate the product of a set of Bs which is greater than 1.0.

The foregoing analysis has been developed for phenomena which can be studied as single closed-loop mutual causal chains. The caveat should be made, however, that multiple causal loops present problems which are considerably more difficult, though soluble.

The reader may remember that in Chapter II the distinction was made between "pseudo-cybernetic" mutual causal systems and "genuine" cybernetic systems. The subsequent development of the cybernetic position indicated that the control center of such a system is designed to operate not only against one type of disturbance, but against all disturbances, even those that are unknown. This attribute suggests that cybernetic systems are inherently morphostatic rather than morphogenetic formulations and are consequently incapable of accounting for change. So long as it is functioning properly, the control center will keep the system within the specified range.

Aside from malfunction, however, there is one situation in which a cybernetic system can be morphogenetic. This occurs when there is a change in the goal state of the control center. It is possible to accomplish this by outside intervention (e.g., changing the setting on the thermostat) or by learning which can be accomplished by multiply-nested cybernetic systems (e.g., computerized chess routines which analyze how well a given move accomplishes its goals). Thus, the point where modifications must be made in cybernetic systems to make them morphogenetic has been pinpointed.

Summary

In this section I have examined a model of and stipulated the logical and empirical conditions necessary for an explanation of growth of communication systems. To accomplish this task, the equivalence of mutual causal loops and axiomatic deductive theories was demonstrated. Also, a typology of system behavior describing both stability and change was developed. Finally, the implications of the results of the analysis were briefly discussed.

The Systems Paradigm of Explanation

This essay has examined the applicability of three different forms of system theory, cybernetics, functionalism, and GST, to the communication process. I will now undertake an examination of the appropriateness of systems theory as a form of explanation compared to the more traditional framework of scientific theory.

The primary purpose of a scientific theory is scientific explanation. A theory is a set of propositions that are so related that taken together they logically explain the occurrence of some particular event. But scientific explanation--as contrasted with other forms of explanation--is an extremely difficult task. It is a carefully defined, narrowly delimited process which contains necessary conditions that must be rigorously met if the outcome of the explanatory process is to be considered valid. In this section I shall argue that the process of explanation as defined by the covering law model of science contains stringent criteria which often cannot be met by communication scientists and that an alternative model for explanation, less powerful but more obtainable--the systems paradigm--ought to be adopted. Further, I shall attempt to support the assertion that the systems paradigm is more appropriate for the study of communication than the covering law model.

Four Explanatory Genres

A theory also serves to predict. But explanation takes precedence over prediction, because a theory which explains must also predict while a theory which predicts need not explain. For example, scientists possessed a theory which allowed prediction of the tides long before they had one that explained them. The same is true of the motion of the planets (cf., Toulmin, 1961).

Explanation can take many forms. Taylor (1970) suggests four types--Scientific explanations, What-explanations, Mental concept explanations, and Reason-giving explanations--and we shall briefly examine these forms to provide a context for our discussion of the systems paradigm alternative.

"Scientific explanation," as defined by the covering law model, consists of a universal generalization that is assumed to be true, a particular set of circumstances, and a conclusion which asserts that an event had to occur because it was deducible from the logic of the propositions of the theory. The generalization upon which the explanation is built is considered satisfactory when it warrants the assertion of counterfactual propositions,

i.e., propositions about what would have happened had circumstances been different. Thus, to establish a theory of communication is to seek a set of propositions that explain how communication operates, i.e., why various communication events are related.

Scientific explanations tell why a thing occurs, but the why is based upon the logic of the set of propositions. The power of the covering law model of explanation stems from the universal generalizations upon which it is built. As we shall see, this is also its most stringent demand which makes the model extremely difficult to use for the study of communication in many circumstances at this time.

"What-explanations" are attempts to specify what a phenomenon is. It is an explanation in that it removes uncertainty about the object by classifying and categorizing it with other phenomena, but it does not explain why the phenomenon is classified the way it is. For example, if we were observing small group interaction and you were to ask for an explanation of what was occurring at the moment, I might use the Bales IPA system and say, "Mr. Sedgwick is asking for orientation and Miss Peabody is showing solidarity." The explanation states how the behavior is to be classifed, but not why. It is in this sense that hypothesis testing is a what-explanation, not a why-explanation unless the hypothesis has been derived (deduced) from a theory based on the covering law model. The theory provides the why explanation. What-explanations can be scientifically useful for classifying phenomena, but they do little to advance our knowledge and understanding of communication.

"Mental concept explanations" are legion in the literature on communication. Examples of these concepts are motive, intention, belief, ability, knowledge, and dispositions. To use one of these concepts to explain a person's action is to describe that action as a part of a pattern of behavior. Identification of a particular action as a part of a pattern of action is explanatory because it classifies the behavior and informs us of what is occurring. Thus, mental-concept explanations are a form of what-explanations. They do not attempt to relate two things in such a way that one could be predicted from the other. This form of explanation may be very useful, especially if the phenomena remain intractable to other forms of explanation. For example, in a recent article, Bennett (1971)[1] suggests that there are three ways of predicting the output of communication systems: a physical explanation, a design explanation, and an intentional explanation, only one of which seems currently tractable when dealing with complex systems, the intentional explanation. He argues that in principle all three would serve to explain, but that in practice, treating a complex system as intentional proves to be the most manageable. When using mental concept explanations (such as intention) we should keep in mind the fact that they do not explain why in the same sense that scientific explanations do.

"Reason-giving explanations" are considered explanations because they show why a person thought that a particular action of belief was right, correct, true, or a good thing to do. It offers answers to the question of why a person felt that a particular action was a good thing to do rather than why the action did in fact occur. The distinction is crucial for it is difficult to argue that mental states are the cause of physical events.

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[1]See also Cappella (in press).

Thus, reason-giving explanations allow us to assess a person's behavior in terms of his mental states and processes preceding his action, and nothing more.

These four explanations vary considerably in the extent to which they can provide strong, useful, valid accounts of phenomena. A strong explanation provides accurate and reliable control in principle over substantial parts of the environment; a weak explanation permits minimal and often unreliable control over a limited part of the environment. Scientific explanation is considerably stronger than the other three modes; it is also the most difficult to achieve.

Problems with the Covering Law Paradigm

The validity of the covering law model is based on the assumption that a generalization can be established that will hold throughout space and time. There are three important problems in establishing the universal generalization. The first is the induction problem. Philosophers have long pointed to the impossibility of examining all cases to arrive at a generalization; hence I will not discuss this point further. The second problem is more subtle. The notion of a universal generalization assumes that a phenomenon will be invariant through time and space. If, however, the behavior of a phenomenon changes depending upon the particular situation of the moment, then the assumption of invariance fails and the universal covering law model is inapplicable.

Many physical phenomena have indeed been shown to be invariant through time and space, e.g., orbiting bodies, gases under pressure, light waves, etc. A number of scholars have argued, however, that such universality is not to be found among human behaviors (c.f., Cushman, and Whiting, 1971, and Toulmin, 1969). Specifically, human communication is seen as culture-bound, rule-governed and characterized by choice rather than law-governed. Each of these points is taken up in the above-mentioned papers (see also Chapter IV), but it is important to note here that if communication is culturally bound, i.e., if symbolic behavior in one situation is not predictive of symbolic behavior in similar situations, then there is no possibility of establishing a generalization and the covering law model is inapplicable to the explanation of the phenomenon of communication. A more appropriate form of explanation is required.

There is a third important point to note about the covering law model: it is based on a single form of logic, specifically, set inclusive logic. As Bailey (1970) says, it is ". . . an attempt to structure reality in a manner so that it can be analyzed according to the logic of classes (p. 55)." There is nothing inherently wrong with this form of logic; it is simply one of several logics available today. The problem is that the covering law model utilizes <u>only</u> this one logical form casting all phenomena and their explanations into the set inclusive mold. Thus, a logic is imposed on the phenomenon to be explained. Toulmin (1969) argues that this procedure is inappropriate for explaining human action:

> We do not <u>impose</u> patterns or ideal forms <u>on</u> human behavior, as instruments within an intellectual analysis: rather, we <u>recognize</u> such general patterns as operative factors <u>in</u> human behavior (p. 100).

I have argued that human communication is not characterized by universal patterns. If this is so, then it suggests that similar communication phenomena occurring in different cultural situations may operate by differing logics. Further, if it is crucial to <u>recognize patterns in</u> rather than <u>impose patterns on</u> human action, then an explanatory form is needed which (1) admits to a variety of logics and (2) permits changes in the choice of logic until one is found which is isomorphic with the phenomenon we seek to explain. In a word, we need a form of explanation which is appropriate to the nature of the phenomenon.

The difficulties in meeting the necessary conditions for employment of the scientific model raises the question of what model of explanation ought to be adopted for constructing theories of communication. Some researchers have been so enamored with the covering law model that they have continued to use it despite the fact that they cannot meet its requirements and commit flagrant violations of its assumptions. Other researchers, in despair of ever meeting the stringent requirements, turn to weaker, less satisfactory modes of explanation--reason-giving explanations, for example--and seem content to operate on that level. I would argue that neither of these positions is useful. If the assumptions of the scientific model can be met, then it is the model to use. If the requirements cannot be met, then while maintaining the ideal of the "natural science" scientific explanation, the most powerful model of explanation should be adopted whose assumptions can be met. Further, it is crucial to choose an explanatory form in which the logic is appropriate to the phenomenon being explained. The systems paradigm is such a model.

The System Paradigm of Explanation

As has been shown in this essay, definitions of systems vary depending upon whether one is working within the domain of general systems theory, structural-functional analysis, or cybernetics. Common to all definitions, however, is the notion of a set of variables together with rules of transformation which define the relations among the variables. The system is

usually defined as closed in that changes in any variable of the system are attributable to changes in the values of the other variables. If the system is open (as in the theory of open systems), then changes in systems variables are a function of changes in system inputs. Without empirical content the set of variables and their rules of transformation which constitute a system is a formal logical structure which says nothing about the empirical world. It is this feature of systems (that they are based on a logical calculus) which can generate entailments for the system, i.e., warranted expectations.

A system is said to explain when: (1) the formal calculus entails expectations, (2) the terms of the calculus are loaded with empirical referents (by rules of correspondence), and (3) isomorphism is established between the logical system and empirical reality. Further, explanation is achieved by showing that:

> (1) If the terms of an abstract calculus are loaded with a given set of concepts, each linked by rules of correspondence to specific empirical perceptions, the rules of interaction of the variables in the system are matched by the relational propositions in the description.
>
> (2) Within the loaded system, the phenomena to be explained appears as a formal entailment.
>
> (3) Other entailments of the loaded system are matched by observations within the empirical situation (Meehan, 1968, p. 57).

The justification for calling this process of determining isomorphism between a logical calculus and empirical referents an explanation is pragmatic--it works, and should the calculus not fit the real world, adjustments are made in the calculus until the two fit. Thus, the systems paradigm incorporates an essential feature of the scientific method, self-correction.

Criteria for Distinguishing the Covering Law and System Paradigms

Having briefly reviewed the covering law and system paradigms, it is important to establish the criteria for distinguishing the two explanatory genres. There are five: (1) the use of generalizations, (2) the use of induction, (3) the relationship between logical and empirical processes, (4) the use of purpose, and (5) the extensiveness of the explanation. I will discuss them in the order listed.

(1) The deductive model is built upon the notion of the universal generalization; the system paradigm, on the other hand, requires only systemic non-universal generalizations. The appropriate statement in the deductive model is, "Throughout all space and time--here and elsewhere, past, present, and future--all X is Y." The non-universal system generalization is, "In this particular time and place--some specific time interval (say, the 1960's) and some specific place (say, the American culture)--all X is Y." The distinction between these two types of generalizations is crucial, for if the argument outlined earlier that communication is culturally bound is accepted, then the covering law model with its universal generalization is clearly inadequate, while the systems explanation which uses situation specific generalizations is definitely appropriate.

(2) The universal generalization of the deductive model is established or certified by induction from empirical observation; without inductive certification deductive explanation is impossible. This fact causes researchers to "focus attention on the common features of classes of events and tends to lead to the examination of a representative sample of the members of a class (Meehan, 1968, p. 49)." The system paradigm, however, is not constrained by the inductive process. Rather, it focuses on ". . .

the web of relations surrounding a single event, and examination of other members of the class does nothing to increase the power of the explanation . . . (Meehan, 1968, p. 49)." Thus, in the systems paradigm any given event may be explained without examination of all other similar events; in other words, induction is superfluous.

(3) A universal generalization combines the empirical and logical processes because it "stipulates the logic of a relationship between two events (Meehan, 1968, p. 49)." Thus, in effect, a universal generalization imposes a logic on events; the generalization stipulates that events be related by the logic of classes. Further, it typically does so without justification or warrant for connecting the empirical description and a logical structure. The system paradigm, on the other hand, separates the logical and empirical processes. Any closed logical system may be employed which meets the needs of the situation. A logical system is sought which will match the logic the researcher recognizes in an empirical event. When isomorphism between the logic of the system and the logic of the event (its behavior) is obtained, explanation is taken as complete. Further, the connection between the two processes is justified on pragmatic grounds, which we shall discuss more fully under #5.

(4) The deductive explanation is a formal paradigm which has been articulated without reference to the concept of purpose. The criteria for adequacy is the ability to generate inductive generalizations irrespective of the use to which the generalization is put. In this sense, adequacy is an all or none phenomenon: either the generalization holds and the explanation is adequate, or it does not hold and the explanation fails. In the systems paradigm, however, since alternative logics may be employed, alternative explanations may be given for the same phenomenon.

Given alternative explanations, a choice among them must be made. The choice can most easily be made on the basis of the purpose for which the explanation was sought.

(5) Deductive explanations offer only single, complete explanations for an entire class of events, e.g., for all precipitation, all traffic deaths, all small group interaction. Explanations of part of the class are not permitted. The system paradigm, on the other hand, does permit partial explanations (which, of course, does not rule out the possibility of a complete systems explanation). Thus, a part of the total number of communication acts which occurs in a small group setting can be attributed to proximity of the people, the status differential, the kind of leadership, the purpose of the gathering, etc.

These factors do not explain all of the communication but do explain some of it. The partial explanation is less powerful than the complete one, but it still is highly useful, especially in a young and growing science such as communication.

Advantages of the Systems Paradigm

There are a number of advantages to using the systems paradigm which go beyond its method of explanation. These include a shift in the particular set of variables which are selected for study, an increase in the complexity of analysis which may be employed, and the ability to integrate current research findings into a wider perspective. Let us look briefly at each of these advantages.

One major purpose of this essay has been to demonstrate that phenomena conceptualized as systems display a number of important properties which are crucial to their operation. Among these properties are (1) stability, the state to which equilibrium systems or steady state systems return after disturbances, (2) variety, or the complexity of a system, (3) constraint, or the relations that obtain among the components of a system, (4) control and regulation, particularly of large systems, (5) information coding and transmission among parts of a system, and (6) growth and death.

These properties suggest a number of useful questions that can be asked about communication viewed as a system. (1) What is an equilibrium or steady state for a person, dyad, or group and what part does communication play in helping reach this state? (2) How does the complexity of the communication system affect performance? (3) What group and societal constraints typically operate to produce communication structure and how does communication structure affect functioning? (4) How does communication function to control and regulate behavior in specified situations? (5) Are certain information coding and transmission techniques more efficient for some tasks than for others? (6) Do communication systems have life cycles; do they evolve through different stages? These and other questions like them should and will be, I believe, the focus of theoretical inquiry in the future.

The second advantage of the system approach is that it permits an increase in the level of complexity of analysis. A parallel might be drawn with Ashby's (1956) law of requisite variety--that only variety can destroy variety--by saying that only complexity can explain complexity. Thus, to provide a full explanation, a phenomenon requires a logic of explanation commensurate with its complexity. As has been argued previously in this essay, most conceptualizations of communication have represented it as an extremely complex phenomenon. This suggests that we need an explanatory model sufficiently complex to account for the complexity of communication. The systems paradigm is such a model.

The third advantage, the integration of existing findings, has already been illustrated. The example at the end of Chapter IV showed how findings from various research sources could be integrated into one explanatory, researchable system. The example was only one of several that could have been sketched.

Summary

In this section, I have reviewed the four primary forms of explanation and argued that the scientific model of theory construction, which has long been the *modus operandi* for communication research, is based upon assumptions which often cannot be met by researchers in the field. Thus, theory construction in the future should abandon the covering law model when its assumptions cannot be met in favor of the systems paradigm, which provides for a slightly less powerful form of explanation, but one whose assumptions can more realistically be met. Further, it has been argued that the systems paradigm provides an explanatory process which is more appropriate to the logic of communication. I believe that the adoption of this theoretical strategy will cause communication scientists to focus on a new set of variables and employ a new set of analytic techniques which will significantly increase their ability to understand, predict, control, and explain the phenomenon of communication.

Comparison and Conclusion

Comparison

The three systems paradigms examined in this essay are more alike than they are dissimilar. This is particularly apparent when the systems and non-systems approaches are compared as was done in the previous section, for any of the three can be substituted for the generic term "system" that was employed there. Understanding the differences and similarities among the three is useful, however, for it is then possible to translate research ideas and procedures back and forth among all of them without fear of violating the assumptions of any one.

All three systems incorporate the concept of purpose. In cybernetics, the purpose is clearly specified as control. In functionalism, the purpose is a system property; it is a feature which the system must create or maintain in order for it to continue in existence. GST also includes the notion of purpose, at least in the case of open system, in the concept of "equifinality", where the same state can be achieved from different initial conditions (cf., Bertalanffy, 1968). They are in agreement in emphasizing the scientific utility of the concept of purpose.

The systems differ in relation to the concept of openness. Cybernetic systems are closed. No matter what outside influences impinge on the variable being controlled, the control center responds only to the discrepancy between the desired and the actual values. Functional systems are generally open, since it is necessary to specify those variables in the environment which affect the system trait being maintained. GST, of course, includes both open and closed frameworks, though as noted before, the emphasis tends to be on open systems.

Perhaps a few additional comments are in order about open and closed systems. Meehan (1968) suggests that the distinction between an open and closed system is the difference between a logical structure and an empirical situation. He defines a system as a set of variables and a set of rules which define the interactions among them, i.e., a system is a logical structure which warrants expectations. By definition, a logical structure is closed, a requirement which is imposed in order for there to be entailments for the system.

Empirical situations, on the other hand, are never closed, that is, they can never be completely isolated from their environment. An empirical situation may be highly isomorphic with a logical system, but since the logical system is closed and the empirical situation is open, the isomorphism will never be perfect. Given that the definition of a system requires that it be closed, and given that only logical structures are closed, Meehan argues that the concept of system is applicable to logical structures but not to empirical situations. An empirical situation should be viewed as just that--an empirical situation, which is potentially isomorphic with some system, i.e., a logical structure.

Because of the necessity to retain the formally closed property of systems, Meehan suggests two techniques to transform into closed systems what others have defined as open systems. An open system is typically defined as one which admits inputs from and expels outputs to an environment. The transformation occurs by treating the input and output as variables within the system which is then considered closed. From a general systems viewpoint this is tantamount to a shift in levels of the systems analysis, except that the inputs to the new level are no longer considered. The second transformation is accomplished by including in the system a *ceteris paribus* clause. The *ceteris paribus* is a way of including the effect of unknown variables while not interfering with system entailments.

Bertalanffy (1968) would undoubtedly disagree with Meehan. As was discussed earlier, Bertalanffy holds that there are fundamental differences when phenomena are viewed as open systems as compared to viewing them as closed.

It has been shown that the logical and empirical requirements for the three systems differ somewhat. It should be possible, however, to transform an analysis from one framework into the other. For example, the cybernetic example of the married couple coordinating their marital relationship by seeking consensus on goals could easily be studied as a functional system which requires a certain range of coordination for survival. Emphasis would then be placed on determining the structures which maintain the trait, and a different empirical procedure would be employed.

The three systems may be compared in terms of their ability to account for morphogenesis. Functionalism seems weakest on this dimension, for it seems to be an analytic framework that is inherently resistent to structural change. Cybernetics, too, has traditionally been a morphostatic, rather than adaptive orientation, but as was shown earlier in the chapter, this need not be the case. The theory of open systems, on the other hand, accounts for adaptive behavior.

In terms of the applicability of mathematical models, both cybernetics and GST are highly amenable to analysis by simultaneous linear differential equations and open systems may be studied by nonlinear, partial differential equations. The case for the mathematization of functional systems, though possible, is less clear, however.

Another commonality which the three share is an emphasis on the continuity and temporal integrity of the interacting elements which constitute the system. Each of these systems is a definable set of relations which continues to exist through some specifiable interval of time. Further, study of their operation over time is necessary for a full understanding of them.

It might now seem appropriate to ask which is the best of the three frameworks for conceptualizing communication, especially since I have already argued that the systems framework is more viable than non-systems alternatives. To choose one system paradigm as superior to another would, however, be contrary to my previous argument, for earlier I noted that part of the power of the systems paradigm accrues from being able to choose a system and evaluate it in light of a specified purpose. Thus, the best system framework is the one which meets the purpose at hand.

Conclusion

Throughout this essay I have attempted to demonstrate that the system perspectives provide a viable, powerful alternative to the non-system frameworks for conceptualizing communication. This has required an examination of the logical and empirical requirements for utilizing the models, as well as their application to the communication process. Numerous examples were provided and the implications for communication research were explored.

But beyond showing that it is _possible_ to view communication from the systems perspective, I have argued that it is _necessary_ to do so, even though such a perspective requires new ways of conceptualizing communication, new research designs, new analytic tools, new variables to explore, etc. Such a complete reorientation would be difficult to justify on any other grounds but one: it is warranted by the nature of the communication process. As Buckley (1967) puts it:

> . . . only the modern systems approach promises to get at the full complexity of the interacting phenomena--to see not only the causes acting on the phenomena under study, the possible consequences of the phenomena, the possible mutual interactions of some of these factors, but also to see the total emergent processes as a function of possible positive and/or negative feedbacks mediated by the selective decisions, or "choices," of the individuals and groups directly or indirectly involved. No less complex an approach can be expected to get at the complexity of the phenomena studied (p. 80).

Hopefully, the advances in conceptualizing communication offered by the systems paradigm will provide new solutions to old problems, make contemporary ones more manageable, and generate new but highly productive issues for future exploration and research.

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